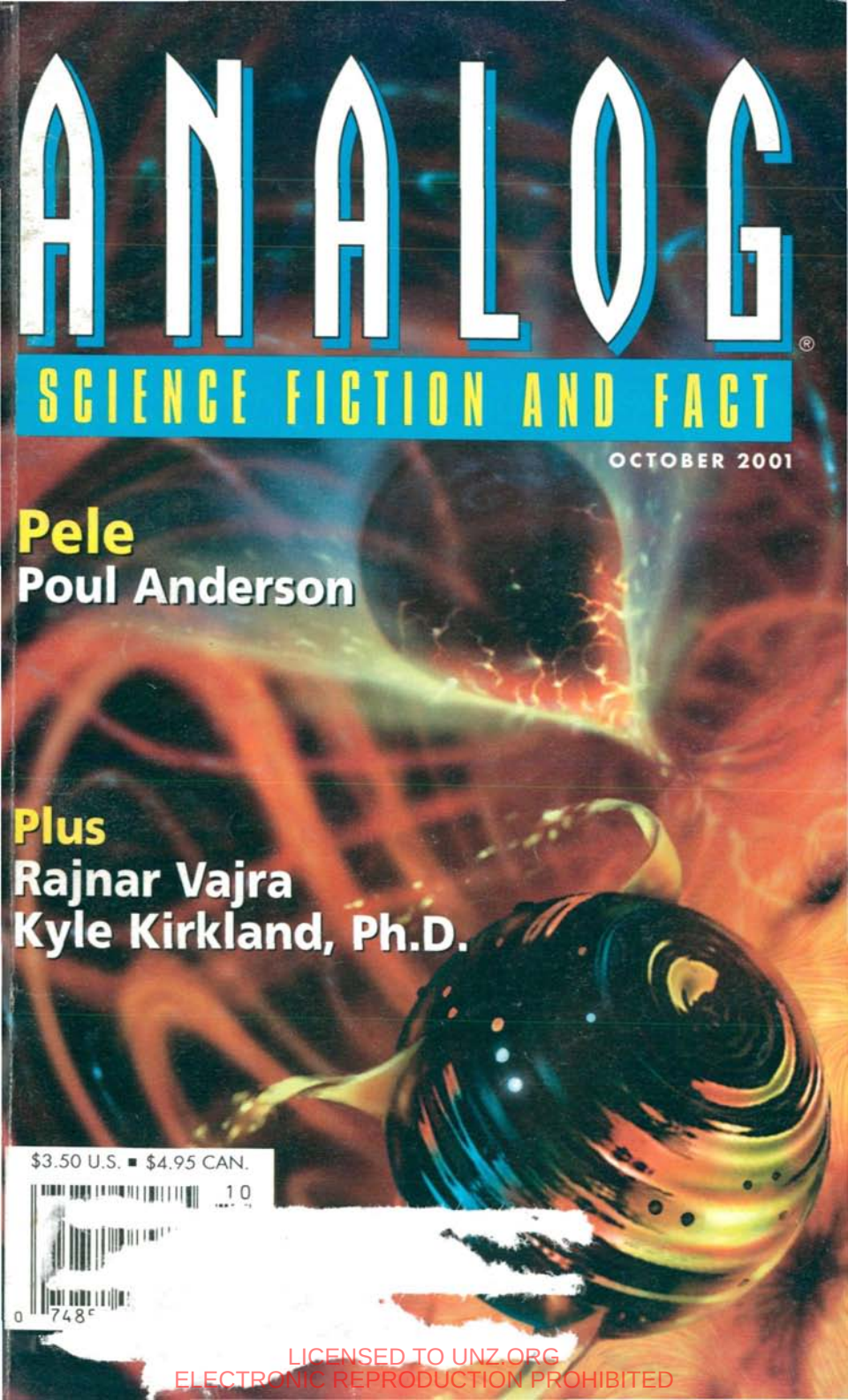

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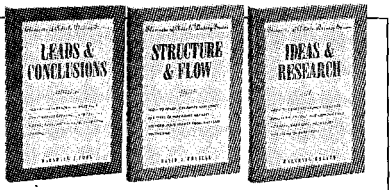

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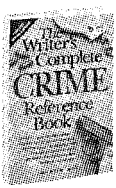

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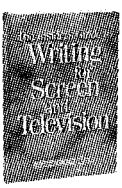

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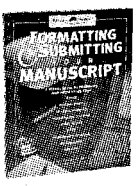

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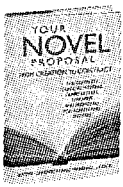

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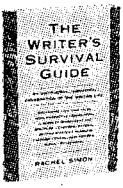

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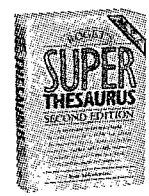

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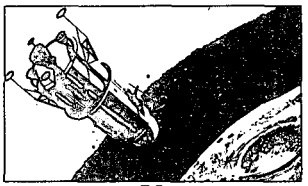

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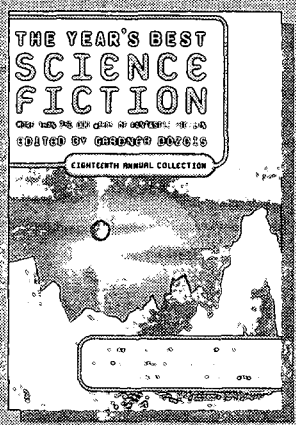

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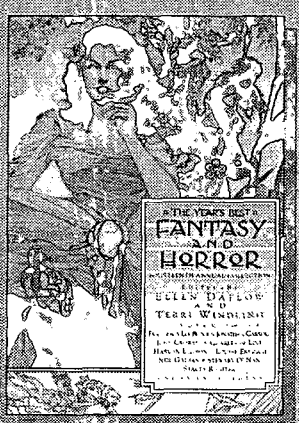

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IMMORTALITY FOR WHOM?

One of the most familiar concepts in science fiction is that of a person surviving beyond his biological lifespan by downloading his personality and memories into a computer or a cloned body. Like most science-fictional ideas that have achieved wide currency, this one has done so for two main reasons: it appeals to a common human desire, and some form of it may actually be achievable. *Analog* has published its share of such stories, and will probably do still more in the future. Yet I can't resist pointing out that there's a hidden fallacy in almost all such visions, which few writers have yet tackled head-on.

The question is this: Assuming that you can find a way to copy the information patterns that define who you are into a new receptacle, so that they can continue processing your memories and interacting with a real and/or simulated environment as you would "in life," have you really achieved immortality?

The answer depends on whom you ask—and by that I don't mean that it's a matter of differing opinions about the facts. I mean that it's a matter of viewpoint. From some viewpoints, the answer is a nice soothing "Yes!," but from one—which might well be considered the most important one—it is clearly, though hardly anyone ever says so, "No."

The fundamental assumption in such proposals is that the essence of a person lies in his or her accumulation of memories and the "programming" that determines how he or she acts, either spontaneously or in response to external stimuli. The details of how authors imagine that principle being utilized vary a lot. The methods of recording the information range from relatively noninvasive and approximate to thorough and precise but destructive. In a relatively primitive version (the only sort we can easily imagine being done any time soon), a person makes a conscious effort to store a great deal of information about himself well before he dies. If this is done in a large enough computer database, and includes enough information about both remembered experiences and ways of responding to situations, the result may be a computer program able to converse with a human in a way difficult to distinguish from an e-mail conversation with the person thus "immortalized."

At the other extreme lie two kinds of options. There's the case where a whole new body identical to (a young and healthy version of) the original is grown and the memories and personality are "transferred" into that. And there's the kind of "transporter" or "matter transmitter" that scans the original by dismantling it, atom by atom, and transmits the information about what was where to a receiver somewhere else. The receiver then reverses the process, building an exact replica of the original, including whatever information was stored in the original nervous system.

Between those extremes lie a number of other variations on the theme. Perhaps the most familiar (or fashionable) at the moment is the "immortality in cyberspace" scenario, wherein a person is "digitized" and can frolic on indefinitely as part of an elaborate "virtual world" existing entirely within the workings of a huge computer. Interaction with biological people is optional in this one. The opportunity may exist, but doesn't have to. The main idea is

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that the virtual world is so complete in itself that it can provide a satisfying life for the virtual person "living" there.

Any of these ideas looks tempting to people who have begun to grasp the fact that they, too, are mortal and would like to find a way out. At first glance, all of these schemes seem to provide one, by transferring the "person" into a new "vessel" where it can live on. According to almost anybody observing the process, that's really what happens. Anybody who knew the real Joe Schmo can interact with the digitized Joe Schmo, or the cloned and memory-transfused Joe Schmo, and say enthusiastically, "That's Joe!" Even digitized Joe, or cloned and memory-transfused Joe, will feel like—will believe himself to *be*—the real Joe, simply continuing his life in a new locale and/or format.

But how about *Joe*—the original, carbon-based, walking-and-talking guy who got himself "converted"? Does *he* feel like he just goes to sleep on the operating table and wakes up in a shiny new body, real or virtual?

'Fraid not. Joe, I regret to inform you, *dies*.

And that's the end of him. He goes to sleep on the operating table and never wakes up, or feels or experiences anything, ever again. He leaves behind what amounts to an extremely elaborate monument to himself, which may be a great comfort to his survivors, but it doesn't do a thing for him directly. It doesn't extend his life; and in fact, if he underwent some sort of destructive scanning, or agreed to terminate his "biological self" when his "digital self" was activated, the process *shortened* his life.

I hate to prick one of the most popular bubbles in science fiction and futurology, but from time to time, I think, people need a reminder of what would really be happening in this sort of situation. The idea of becoming immortal by transferring your "self" into a new container has such a powerful appeal that people are understandably drawn to it, and maybe too willing to assume they'd be getting more than they would. That makes it hard to think critically about what's really happening—and what's really happening is not trivially simple to begin with.

Any of the schemes I've described would mean Joe gets to live on, *if* his "personhood" were something like a given quantity of fluid that could be poured from one vessel into another. But it isn't. In any of those processes, his personality and memories are not *moved*, but *copied*—and the original, now or later, is destroyed.

The situation is very much like what happens when you "move" a computer file by dragging its icon from one disk to the icon for another disk. It might be worthwhile to pursue that analogy, to get rid of some of the excess baggage that comes with talking about "people" and thereby make the essentials easier to see.

We'll start by considering what happens when you copy the contents of one ordinary floppy disk onto another. Call the first disk "Floppy 1," and say that its contents consist entirely of an office soft-

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ware package which we'll call Officemeister. Copy it onto another floppy, which we can call anything we want—say, "Floppy 2"—and the contents of Floppy 2 "are" also Officemeister. That is, it's not the same copy of Officemeister, but it's identical in its functioning. Anything you can do with one copy, you can do exactly as well with the other. As the computer user, you don't care which you use, and if one copy is destroyed, it doesn't matter to you because you have another, completely equivalent. From *your* point of view, Officemeister is immortal; as long as at least one usable copy exists, the program is as good as new. And since the program isn't self-aware, there's no one on either disk to disagree with you.

But now imagine something like a floppy disk only more so—one that does the same kinds of things, but *is* self-aware. Let's call it "Superfloppy A"—and it *knows* that it's Superfloppy A.

Now suppose that we copy Superfloppy A's entire contents onto a new superdisk. *We* can call it something else, if we like, but since its contents include self-awareness, *it knows* that it's Superfloppy A. From *its* point of view, Superfloppy A lives on, even if something catastrophic happens to the original Superfloppy A. From *your* point of view, too, Superfloppy A lives on, even if something catastrophic happens to the original Superfloppy A. You and the copy agree that Superfloppy A lives on, even if the original is destroyed.

But the original does not! If the original is destroyed, it is *destroyed*, and has no future—and since it is self-aware, that matters profoundly. If its self-awareness includes an interest in self-preservation, that interest is not satisfied even if it knows that a copy of itself survives somewhere else and can continue doing its work just as it would.

And *that* is the sort of thing that happens when a person is "transferred" into cyberspace or a cloned body. If you're contemplating undergoing such a transition, this realization might give you second thoughts. You should be aware that the process will *not* give you personal immortality, though it may give everybody else a convincing illusion of that. It will give your heirs an elaborate, interactive memorial to you; it may even allow your personality to continue influencing events in the real world (though one might reasonably question why you should want it to, when you are no longer a part of that world, and even whether it should be allowed to).

But *you* will have to decide whether those things are worth dying for—and you only get one chance. ■

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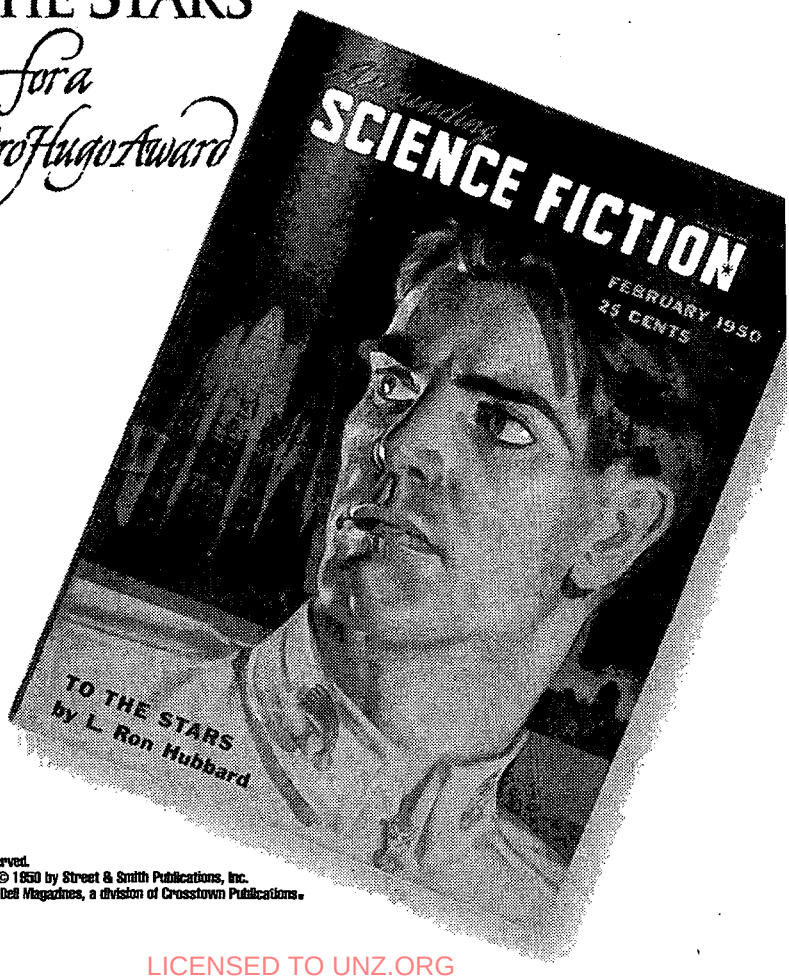

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Pele

Poul Anderson

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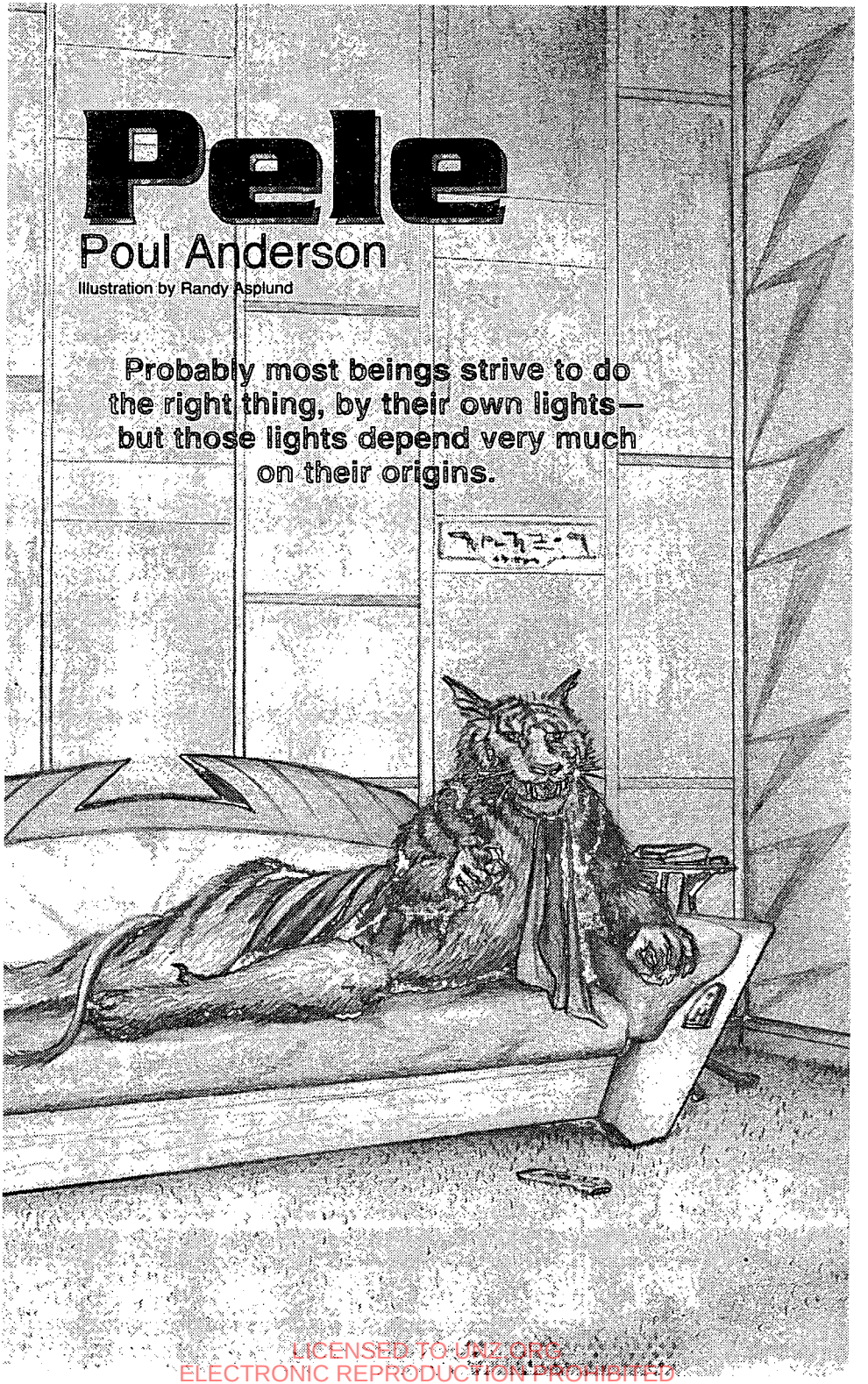
Probably most beings strive to do the right thing, by their own lights—but those lights depend very much on their origins.



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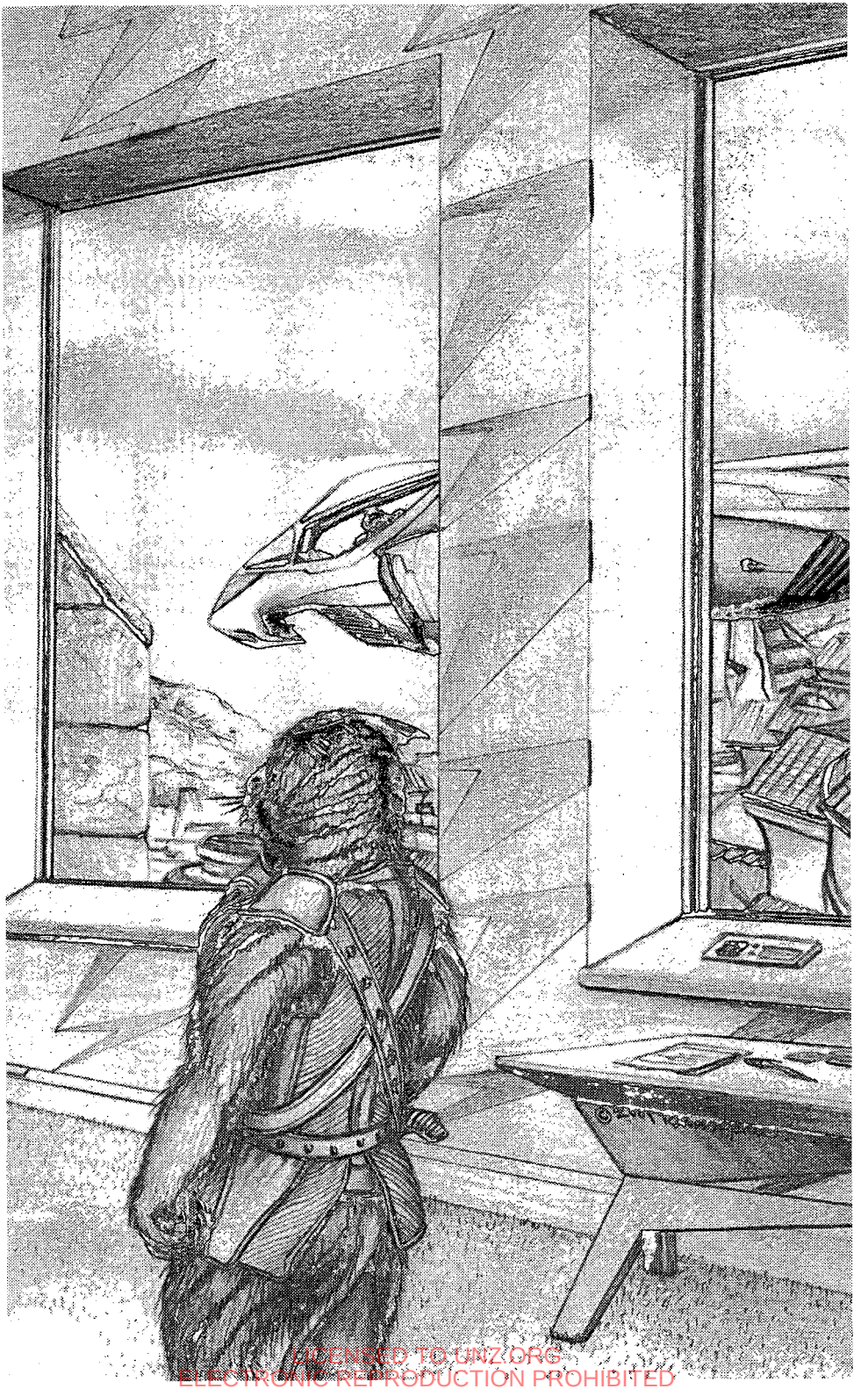

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Close to noon, the Father Sun baked pungencies out of turf and turned the forest that walled the northern horizon into a wind-whispery surf of leaves and shadow. Closer by, a field of *hsakh* stood golden. Kdatlyno slaves were hand-cultivating it in the ancient way, growing fiber that would be hand-woven into cloaks for the mighty to wear at Midwinter Bloodfeast and then burn. Scattered elsewhere were the dwellings of the Heroes attendant upon this household. Though stately enough, they were dwarfed by the manor looming ahead of Ghrul-Captain.

These lands were a minor holding of Grand Lord Narr-Souwa's and the building was fairly new, in a modern style. Mosaic of red-and-black thunderbolt pattern decorated walls that sheered up to steep roofs of copper kept blindingly polished, whose beam-ends gaped in the forms of carnivores. Tradition had made the lower windows mere gun-slits, but those on upper floors were arrogantly broad. Saw-toothed spires at the four cardinal points flew ancestral banners.

As was fitting, Ghrul-Captain had come afoot, unaccompanied, from a landing field now out of sight. But he loped like a warrior to battle and passed the gate with head high. A display of fearlessness also behooved him, showing him not unworthy to enter the presence of the one who waited here.

His hopes heightened when he received due courtesy in return. A pair of armed Heroes met him, gave greeting, and escorted him down a granite corridor to an elevator, and thence to a flamewood door that recognized them and slid aside. There they left him. Ghrul-Captain stepped through. The door silently slid shut at his back.

The chamber was austere, paneled with various metals, floor turflike and sound-absorbent. Two open windows let in daylight and summer air. He glimpsed a hookbeak at hover outside. Furnishings were scant, mostly a minimum of communications equipment. He was alone with Narr-Souwa.

That Grand Lord half-reclined on a couch, like a slashtooth at its ease between hunts. He bore no weapons other than his teeth and claws. His only ornament was a scarf loosely draped across a frame whose black-striped orange fur was getting grizzled, but the scarf was of genuine silk, somehow brought from Earth itself. His eyes smoldered yellow, undimmed by the years.

Ghrul-Captain did not simply come to attention and salute, as he would before an ordinary superior. First he lowered his head and knees, tail between thighs. That galled him. It was meant to, he knew. He should think of it as a test. The sword blade, bent, will spring back to keen-edged straightness and ring as it does, if the steel be true.

"Ghrul-Captain of the Navy begs leave to present himself." The request sounded flat in his ears.

Narr-Souwa peered at him for a while that grew long. "You may relax," he answered at last. "This interview is at your plea. Justify yourself."

Ghrul-Captain had rehearsed in his mind. "As my lord knows, I advanced my *proposal*"—he laid a measured weight on that word—"through proper channels. I never looked for response at this exalted level, and still less the glory of a flesh-meeting." Which might, he thought, be the prelude to a death sentence. If so, may I be turned loose in yonder forest for him and his hunters to chase down as they would any other brave, dangerous animal. Maybe I can take one or two to the Darkness with me.

"I want to get the actual scent of you and the sense of how your blood runs," explained Narr-Souwa. "Yours is an unusual suggestion . . . especially from a member of your house."

I have nothing to gain, much to lose, by self-abasement, Ghrul-Captain knew. "Sire, my wish is to redeem the honor of

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that house."

Narr-Souwa stroked his chin. "Honor has been satisfied. High Admiral Ress-Chiuu made a decision and issued orders that proved disastrous. It cost us a warship's whole complement. Worse, it let that ship fall into the hands of the humans. Their naval intelligence has surely been dissecting it ever since. When condemned, Ress-Chiuu went boldly into the Patriarchal Arena and acquitted himself well against the beasts. It was good sport."

Ghrul-Captain drew breath. "So their spokesmales have graciously informed his kin. But, sire—my lord will understand that we want to make full redemption."

Narr-Souwa's eyes narrowed a bit. "And thus regain his holdings, as well as the prestige," he said shrewdly. "The database has told me that you would inherit his estate in the Hrungn Valley."

For an instant the memory and the yearning stabbed Ghrul-Captain, lands broad beneath the Mooncatcher Mountains, castle raised in olden days when kzin fought kzin hand to hand, graves of his forebears, a wilderness to rove in freedom. He curbed himself. "My lord is wise. But I wish yet more to win back the trust, the favor, that raises to leadership."

He had kept the title to his half-name, but been relieved of command over the *Venomous Fang* that had been his. Small she was, but swift, agile, deadly. Ah-hai, the beautiful guns and missiles, the standing among his peers and over his crew, the tautness of close maneuver, and space, space, the stars for a hunting ground! "More than life do I want to take a real part in the next war," and gain repute, a whole name, the right to breed.

Narr-Souwa folded his ears a bit, unfolded them again and murmured, "So you expect a second war with the humans?"

"Doesn't everyone, sire?"

Contempt spat. "*They* hope otherwise. Most of them."

Ghrul-Captain deemed it best to wait.

The Grand Lord sighed. "We need time to make ready, time. The more so after that major setback at the ancient red sun. This later affair at the black hole was less catastrophic, but—it has doubtless changed the minds of still more monkeys about us. Certainly they now have important data on our Raptor-class ships."

"With deepest respect, sire," Ghrul-Captain ventured, "I submit that we should not let them gather information we do not even possess."

"Hr-r-r, yes. That expedition they are planning, to the young sun and its doomed planet. Well, but what intelligence we have on it inclines me to believe it will be what they claim, *purely scientific*." Perforce Narr-Souwa spoke that phrase in the closest rough, snarling approximation to English the kzin voice could manage, for nothing quite like it existed in any language of his race.

Here was a moment to show initiative and thoughtfulness. "Monkey curiosity, sire. I took this into account. They are—no, not so much flighty as . . . playful. The most playful breed in known space. The oldest of them are like kittens."

"Kittens that never grow up to realism or dignity. Vermin of the Universe. . . . But how does this little new game of theirs concern us?"

"Sire, I tried to make that clear in my petition. They suppose they may learn something they do not yet know. What that might be, they do not know either. It may well prove of no practical value. Nevertheless, my lord, those monkeys have a way of turning anything into a weapon if they feel the need. Anything."

And thus they beat back our invasion, Ghrul-Captain recalled, and were the first to acquire the hyperdrive, and stuffed what they snivel is peace down our throats. He nearly gagged.

"Granted." Narr-Souwa's eyes seemed to kindle. His whiskers lifted, his voice dropped to a purr. "Do you imply the

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Supreme Councilors have not studied the enemy's history?"

"Of course not, Grand Lord," Ghrul-Captain protested. "Never!" Boldness was advisable, within bounds. "Still, sire, they have much to think upon, many spoor to trace. I merely offer them an idea."

Narr-Souwa mildened and nodded. "That we should dispatch an expedition of our own there to observe what happens."

Ghrul-Captain knew better than to reply, "Yes, sire," as though expressing agreement with a near-equal.

"It is not a bad thought," Narr-Souwa went on, quite softly. "No, not at all bad in itself. And—I have personally reviewed your record—you are in fact well qualified to lead such a faring. You have had experience with technical teams. In two situations that could have become troublesome you exercised sound judgment. Such restraint does not come easily. Well do I know."

Rapture flowed into Ghrul-Captain, that a great one would speak personally and at such length to him, *him*. "May I always hunt well and bring home a pleasing quarry, sire!"

The tone went businesslike. "Perhaps you do not quite grasp the difficulties. Time is short until the event. Likewise are our resources for space operations."

Encouraged, Ghrul-Captain said, "The lord will remember that my proposal goes somewhat into specifics."

"To the extent of your knowledge when you composed it. Hr-r, the details can quickly be settled—and must be, if we are to act. There is also another matter, to which we must reluctantly accord importance."

"Will my lord enlighten me?" If he does, blazed through Ghrul-Captain, I'm in!

"We shall not spare a warcraft for a mission as dubious of profit as this," Narr-Souwa said methodically. "Besides, that would be a mistake in any event. As I indicated earlier, because of the incidents I mentioned those humans who credit us with hostile intent have gained a certain advantage over those who wish it were not so and"—sardonically—"to borrow a monkey saying I have heard, let the wish become the father to the thought. We would be unwise to make any fresh overt move that could strengthen those who call themselves the advocates of preparedness. To send a combat vessel to a star they have announced they will be visiting and will have a presence at for a long time to come—that would probably be such a move."

"Sire, I have admitted that the Council would likely order economy of means. Indeed, I respectfully advised it," bearing in mind the needs of a navy, still rebuilding after its shattering defeat, which must meanwhile keep control over the remaining kzin empire.

"We can assign a transport, no more." Yes, clearly Narr-Souwa had pulled in all available information and tracked out all its implications beforehand. "It will carry what auxiliary vessels may be needed, but nothing adequate for a serious engagement. This being the case, our psychologically best gambit is to let the humans know that we do intend to send such a scientific group. Do you seize my meaning?"

"Yes, sire. An earnest of peacefulness, of desire to cooperate—Aargh!" Ghrul-Captain could not hold the growl back.

Narr-Souwa took it understandingly. "Beware of otherwise natural emotions," he warned. "Quite possibly, once they hear from us, the monkeys will provide their ship with an armed escort. That crystallizes the necessity of quiescence. Think of a male, spear-hunting slashtooth, who must withdraw and bide his time if a whole pride of them comes down the trail. Later he will find one alone."

Ghrul-Captain gulped. "My lord speaks wisdom. I will not forget."

"I trust not. Your record gives reason to expect you can hold yourself and

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your crew on a tight leash. It will be a test of your fitness for a new and higher command."

Ghrul-Captain quivered. "Yes, lord, but—but we won't only make our observations from afar, like the monkeys. We'll try—discreetly, yes, of course, lord—try to learn what they do discover and what they infer. I think we can beat them at their own game too, and show them what Heroes are."

"Do not take risks merely for the sake of that."

"No, lord, certainly not." It might be harder to curb his personnel than himself, but Ghrul-Captain felt confident. "However, as my proposal notes, we have a special craft available to us, the prototype of *Sun Defier*. My lord doubtless knows that that was the tug designed and built for Werlith-Commandant's mission to the ancient star, able to operate closer to it while keeping the crew alive than any other vessel in known space. It was lost in the debacle, but the engineering works has kept the preliminary model that tested the concept. This is much smaller, of course, less powerful, but unique. The humans have nothing like it. They prefer to orbit afar, send in robotic probes, and not hazard their own precious pelts. Lord, a live pilot might well observe and experience things that it would not occur to a stupid robot to try for. We may win a prize the monkeys never realize existed."

"Yes-s, that will be good, if feasible. You must decide on the spot." Narr-Souwa paused. "Return with whatever accomplishments are yours and give them to our judgment. Then we shall see what further you have proven yourself worthy of. We shall see."

2

"This has changed everything," said Peter Nordbo.

"Yah. Obviously," answered Robert Saxtorph. "Damn. *God* damn."

He had jumped from his chair on hearing the news. Now he sat back down, heavily in spite of the light gravity. For a moment his gaze went from the man behind the desk, outward, as if in search of help.

He found no more than beauty. The main office of Saxtorph & Nordbo lay near the top of a building which, although on the edge of town, rose tall. One window held sight of the roofs, towers, steeples, and traffic of München. The other gave on green countryside, scattered homes and groves, a distant range of hills blue against a blue sky. Alpha Centauri A spilled morning radiance across it. B was not yet visible and, currently close to maximum separation, would shine only as the brightest of the stars. A flight of rosewings passed across a snowy cloud. Kind of like wild geese, he thought vaguely, but sunrise-colored. Not that I've ever seen wild geese, except on a screen. Yes, Wunderland's still a lovely world, as alive as Earth used to be before people screwed her up.

"It would not have been a particularly profitable charter for us," said Nordbo.

Saxtorph's burly frame swung around to confront the gray-bearded face. "No," he admitted harshly, "but Dorcas and me, how we lusted to go! What a bodacious spectacle! And the publicity would've been worth more than the money," to the single privately-owned hyperdrive craft in known space, competing with the lines of half a dozen governments.

"That has become worse than worthless."

"How?"

"I've had time to think this over, you know." Saxtorph and his crew had been en route from Jinx with a load of organics cheaper to grow there and haul here than to synthesize. Centaurian industry hadn't fully recovered from the long kzin occupation. Maybe—his mind wandered again for a second—it never would, but concentrate instead on whole new kinds of enterprise. Which ought to leave room for *Rover* to ply her

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trade.

But he didn't want her always to be just a tramp freighter. She'd been more. He'd left with his head full of the wonderful discovery the astronomers had made, the fact that an expedition to go for a close look was being organized as fast as possible, and the near-promise that his ship would carry it. She'd proven she could survive pretty terrible surprises, she'd have no other commitments, and Nordbo was closing the deal. It helped that the headquarters of the Interworld Space Commission were handy, right in this same system; he'd gotten on friendly terms with key bureaucrats.

If only the engineers had miniaturized hyperwave transmitters enough that a ship could hold one, Saxtorph thought, not for the first time. Then: What'd have been the use? I'd've gotten the bad news sooner, that's all.

"*In der Tat*," Nordbo went on, briefly reverting to Wunderland's chief language, "I saw at once that the ISC would forbid you to go, and forestalled them by offering to cancel the contract myself. It was the responsible thing to do, anyway."

"Are you sure?" Saxtorph challenged almost involuntarily.

"Yes. You will be too, once you've swallowed your disappointment." Nordbo sighed. "Robert, we agreed when I became your partner, *Rover* will steer clear of any volume of space where there's a significant chance of your encountering kzinti. You destroyed their base at the ancient star and uncovered the secret that they now have the hyperdrive. You killed a naval crew of theirs at the black hole—"

"Self-defence," Saxtorph snapped. "Both times, it was them or us, and we didn't start the fracas. The second time, it was Tyra also."

"You needn't tell me."

Saxtorph's massive shoulders slumped a bit. "Sorry. I got carried away. . . . Yah. Aside from the few of them amongst us, probably every kzin alive would cheerfully die to collect my scalp." He straightened. "But, hey, do they have to know it's *Rover?* Change the ID code, disguise the body lines, give her a new paint job."

Nordbo smiled wryly. "Forever the optimist, aren't you? No, much too risky. We'd certainly lose our insurance."

"Uh-huh," Saxtorph must agree. "Seeing as how they'd be in a tiny danger of having to pay up."

"The danger would not be tiny, and it would be to you and yours, Robert."

Dorcas, Saxtorph thought. Her, and everything we've shared all these years, and the kids we still hope to have someday. Not to mention Kam, Carita, and Buck. And any passengers.

"The kzinti say their expedition will be strictly scientific, like ours, employing simply a transport and a few auxiliaries," Nordbo continued. "But everybody knows that will be a naval transport with at least some armament. If they learned *Rover* had come, as they might very well—No, it would be too much to expect of kzinti, not to attack."

Saxtorph surrendered. "OK. OK. You've gotten through this thick skull of mine. You're right." He rallied his spirit. "What'll we do instead?"

Nordbo smiled afresh, warmly. "The coin has a bright side. Because I saved the ISC embarrassment, I was able to drive a bargain. They naturally prefer our names never be associated with this. So . . . we keep silence. In return, we have a commission to bring several special cargoes to the puppeteers' tradepoint and distribute the exchange goods to four different human planets."

Joy flared. "Holy Christ! Clear to there!"

"And well paid. With a clause that will allow us to develop the route further for ourselves if we choose and the puppeteers are willing."

"Pete," Saxtorph declared, "I take every hard thought about you back. I apologize, I heap *sthondat* dung on my

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head, I adore. You're flat-out a genius."

A parallel gladness: How grandly this guy's gotten over his decades of exile, a kzin prisoner, and the death of his son. Even though I got the reasons for it made an official secret, he knew, he knows. He threw himself into our partnership to escape. Oh, he did a lot more than furnish some capital we badly needed—he hadn't lost his skill at handling people, either—but it was an escape. In the three years since, however—He and his new wife seem about as happy as Dorcas and me. And now he's wangled this for us.

"Aw, shucks," said Nordbo. "Isn't that your American expression?"

"Your triumph calls for a drink, followed by unbridled celebration." And, Saxtorph thought, what happens at the cannibal star will be fun to watch when the databases arrive home. We'll've been having real-time adventures and just as much fun, or maybe more.

He took forth his pipe and tobacco pouch. "First, though, fill me in, will you? Who's going to carry the mission?"

"I helped arrange that, too," Nordbo told him. "A little reshifting of schedules made the *Freuchen* available."

"Oh, fine. She *is* mainly for exploration—done good work in the past . . . A tad crowded, maybe, for an expedition like this, with the tonne of gear I imagine they'll want to take."

"They'll have ample extra room. A naval vessel will escort them."

Saxtorph grinned. "Well, well. The ISC's being smart for a change. Nothing 'provocative,' no, never; but the kitty-cats won't be tempted to touch off an 'incident' and claim afterward it was our side's fault."

Nordbo nodded. "That's the unspoken idea. Nobody wants a fight, myself least."

"The *Freuchen*. . . . Yah, the establishment—scientists and politicians both—owe us one, over and above the puppeteer contract. They owe you, rather."

Nordbo gave his friend a steady look. "I cashed in that part of it. Which is why I'm especially relieved by their having an escort."

"Hey?"

"Tyra's going along."

"Huh?"

"She was after me about it from the first. A writer by trade, and what a story to tell! I managed to make her assignment part of the bargain, and didn't suppose you would object. Not but what they won't get their money's worth. She'll make the public love that science."

"Well, yes, she always was a venturesome sort. Not strange, seeing she's your daughter." And can wind you around her finger, Saxtorph said silently. As she damn near did me, till she decided not to finish the job. I've never said anything to you or anybody. Nor did I stay regretful. Dorcas and me do belong together.

He knew how suddenly seriousness could grab hold of the other man. Nordbo generally kept his deepest feelings to himself. But he and Saxtorph had grown close, and from time to time everybody needs somebody who will listen.

"Robert, she's been unhappy. She doesn't let on, she wouldn't, but I can tell. I don't know why. Yes, she's grieved for Ib, side by side with me, but—but that's past and done with. It isn't like her to brood. Is it?" He had missed out on the years when she grew up.

Did our not-quite-affair really hurt her so badly? wondered Saxtorph. I sure never thought that, seeing how she behaved. Afterward—well, friendly when we've met, of course, but in the nature of the case, that hasn't been often.

What can I do except wish her everything good?

"No, her style is to get on with her life."

Nordbo steadied. "She's been doing so. It's simply that I felt her heart wasn't altogether in it. Now, I do believe, this prospect, this amazement to see and take part in, I think it's healing her."

* * *

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3

Having climbed high enough up the complex and changeable Alpha Centaurian gravity well, the lancer *Samurai* slipped into hyperspace. *Freuchen* followed seventy-two hours later. The naval ship was to reach destination first and make sure of security before the civilians appeared.

Although no passenger liner, *Freuchen* often made long voyages, and long stays at the far ends of them, which might well involve hardship and danger. Facilities for privacy, recreation, and exercise were not a luxury but a necessity. A couple of watchcycles after leaving 3-space, Tyra Nordbo and Craig Raden were in the gymnasium playing recoil ball.

That game takes strength and wind, as well as speed and agility. This being a Wunderland vessel crewed mostly by Wunderlanders, her gravity polarizers maintained the interior weight to which they were accustomed. Nevertheless the Earthman found himself hard challenged. The match ended with score tied and both breathing from the bottoms of their lungs, sweat agleam and animal-odorous on their skins.

"Whoof!" Raden laughed. "Congratulations and thanks. You gave me a good one."

"The same to you," Tyra answered. Her tone was warmer toward him than hitherto. It had been fun. And, she must admit to herself, the sight of him was fun too—medium-tall, slim and supple but well-muscled, features Roman-nosed and regular, with bright hazel eyes, beneath wavy brown hair. That doesn't mean I have to fall over you—or under you, said defensiveness.

"Frankly, I didn't expect it from a person of your origins."

Then why did you invite me to play? she flared inwardly. An approach? Likely. They say you're quite a tomcat. "We're healthy," she snapped.

"Oh, absolutely. Normal adaptation to a lower gravity. No offense intended, please believe." Raden shook his head and clicked his tongue. "Foolish of me. I should have given more thought to what I saw, besides enjoying the view."

He made no pretense of doing otherwise. Tyra's height equaled his, which was not surprising in a Wunderlander woman, but damp T-shirt and shorts clung to a figure as full and robust as that of any Earthling female in good condition. Flaxen hair in a pageboy cut framed a face strong-boned and blunt, where little save a few fine lines at the blue eyes hinted at an age of about forty terrestrial years, perhaps three more than his. "You'd be unusually athletic on any planet," he added.

She shrugged. "I'm not obsessed with aerobics. I just enjoy some activities."

"Which especially, if I may ask?"

"Swimming, wingsailing, hiking, mountaineering, that sort of thing."

"Tastes we share, then. The results do come in useful occasionally, don't you agree? I understand you too have spent a fair amount of time on different worlds, and not merely in their tourist resorts."

"My work. Gathering material, getting ideas." He's pushing familiarity pretty fast, isn't he? "You're an astrophysicist." Put him in his place. Imply that his travels were a gadding about.

Raden's smile faded, his voice went amicably earnest. "Look here, Fräulein Nordbo, may I suggest we become better acquainted? We've a rather long haul before us, and then a time about which we can predict nothing other than that it will be busy, till we've done whatever we can. Let's go as friends."

"Have I seemed unfriendly?" she asked with caution.

"No, no. A bit aloof, perhaps."

"We're barely into the voyage."

"Why not start it on the right foot? Suppose after we've washed and changed clothes, we meet in the wardroom. I'd be honored to stand you a drink or two before dinner."

"Honored? You?" She spoke coldly, to

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make clear that she didn't like being patronized.

He caught on at once. "I'm sorry. I truly am. What I wanted to say was 'delighted,' but I was afraid of seeming too forward. You're known as a formidable sort."

That's hard to resist, Tyra confessed. Damn him, he can turn on the charm like a light. Anyhow, it's true, we need to become comrades, all of us on board. There's unknownness waiting yonder, and kzinti.

"Not intentionally." She didn't have to force her smile. "Thank you, I'd be delighted myself. In half an hour?"

Command and competence were as vital as in any spacecraft, but an explorer did best without social distinctions between ranks off duty. The wardroom was open to anyone who wanted sociability. Nobody chanced to be present but steward Marcus Hauptmann and planetologist Kees Verwoort, pushing chessmen. Already at ease with Tyra, they nodded as she came in. Nattily attired, Raden jumped from a chair and strode to meet her. "Ah, jolly good," he said. "What would you like?"

"Draft Solborg." She sat down at the little table where he had been. Several more were spaced around the room with their chairs, plus a few loungers. Underneath each was the magnetic inductor that would secure it to the deck in case of untoward acceleration or free fall.

"Forthcoming. Hm, not too early in the daywatch for a glass of wine. They've shipped a reasonably decent dry Riesling." Raden got them from the dispenser, which debited his personal ration, and brought them over. He took his place opposite her and lifted his goblet. "*Skaal.*"

So he's remembered, Tyra thought, or he's taken the trouble to find out, things about me like my hailing from Skogarna, and that this is our toast there instead of "*Prosit.*"

She didn't know how to feel about that. Well, pay him in kind. "Here's how," she responded.

Glasyl clinked against stein. The beer was a welcome tartness in mouth and throat.

"Ah-ha. Then you know I'm American, Fräulein Nordbo?" Raden said genially. "Most people off Earth seem under the impression I'm a Brit."

"Next time I'll say 'Cheers' if you prefer." Was she parrying something?

He laughed. "*Touché!* Yes, I admit to certain affectations. And I did study for a while at Cambridge." He sipped and went on in a philosophical tone. "Such details are apt to look vanishingly small across a few light-years, aren't they? Consider how societies diverged when only subluminal transit was available. They've not had much time or opportunity thus far to catch up, have they? Rather amazing, how knowledgeable you are."

Is he showing off his serious, intellectual side? wondered Tyra. Or do quantum jumps come naturally to him? "No surprise, Dr. Raden. Writers collect oddments like glitterfowl. You know that."

"Well, yes, I am a writer too, of sorts. But secondarily. Not a rival of yours on this mission or, I hope, ever."

"I've seen your popular science works, those of them that have reached us, and your 'Multiverse' show." Be honest, she told herself. "I've enjoyed them, in fact admired them."

"Thank you. I look forward to seeing what you've done."

"Nothing like yours. Mainly travel pieces, some assorted journalism, some fiction, a couple of things for children."

"I'll doubtless write up this expedition and its findings myself, elsewhere than in the scientific databases. But I don't imagine I'll overlap what you do in the least."

And my audience won't be ten percent of yours, even if my accounts get distribution on Earth, Tyra realized. The famous young scientist, popularizer, lec-

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turer, sportsman, yes, licensed spaceboat pilot and bronze medalist in the Saturnian Ring Run, all very well publicized. Showman. Unfair? Am I being nasty and jealous? Or just shy? I'm not sure. I'm not used to either of those feelings.

"I have in mind telling about the people with us and what happens to them personally," she said. "But you will do that too, along with explaining the discoveries, same as always, won't you?"

"Mostly incidentally, trying to get across that science isn't a revelation handed down from on high, it's something that intelligent creatures do. You'll concentrate on the human story. We are not in competition. We may well prove to be in cooperation."

"M-m, maybe. You're kind to say so, Dr. Raden."

"Please," he replied gently, "must we continue formal? I'm Craig to my friends."

Impulse grabbed Tyra. "And I'm not properly 'Fräulein.' I've resumed my family name, but I was married twice."

His gaze searched her. "To what kind of man, that they'd give up one like you?"

She flushed, but stiffened less than she probably should have. "Things simply didn't work out. If I'm not mistaken, you've had similar experiences."

"True. And I'm not self-righteous about them, either . . . Tyra." Quickly: "Yes, I'm trying to cultivate your acquaintance, not entirely for its own sake. I hope we can talk about your adventures at the black hole."

"That was Captain Saxtorph's department," she demurred. "I was hardly more than a passenger."

"Forgive me, but according to what I've gathered, you're overly modest. You had a great deal to do with what went on." Again quickly: "Although you've wanted your part in it de-emphasized as much as possible. Aristocratic reserve?"

As little as possible about Ib—she put down the pain. "Wunderland doesn't have aristocrats any longer."

"Still, the heritage, the pride. . . . This very ship bears the name of your clan. . . . Well, I certainly don't mean to intrude. If ever I ask anything, or say anything, you don't like, please let me know. I swear to respect your privacy."

Disarmed, she blurted, "What'll be left to talk about, then, that you can't have retrieved from public databases?"

"Endlessly much. You and your companions met something unique in our knowledge—a mini-black hole, and the artifact the tnuctipun built around it, billions of years ago. . . . Gone, now, gone. Surely you see what this means to me and every astrophysicist, cosmologist, archeologist, anybody who's ever looked at the stars and wondered."

"I only had glimpses and heard others rattle off numbers they'd taken from their instruments."

"I think you observed more, perhaps more than you know. At any rate, I'll wager your story of it is vivid."

Tyra could not but smile. It was as if his enthusiasm smoothed away every lingering hurt and reopened her eyes to wonder. "You flatter me."

He turned playful. "I'm good at that. Especially when it's sincere."

She laughed. "We'll have time enough under way."

"Yes, indeed. I won't be champing at the bit as impatiently as I expected. Thank you, Tyra."

He led the conversation on to undisturbing reminiscences, anecdotes, jokes, a cheerful hour.

4

An alert yowled. Ghrul-Captain sprang from his lair, down a passage and up a companionway to the main control chamber. He shoved aside the watchkeeper, a kzin currently known as Subofficer. "Sire," the underling told him, "the optics and nucleonics register a spacecraft approaching."

"What else would it be?" Ghrul-Captain snarled. "Do you take me for a

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sthondat?"

"No, sire, of course not—"

"Silence till you have something worth saying, if ever." Ghrul-Captain crouched into the central command seat.

The other drew back, submissive but poised. Bristling whiskers, broadened pupils, and half-folded ears showed anger. It was purely reflexive, not directed at his superior. This was what happened to one of his standing, like harsh weather on a planet. He may have counted himself lucky not to be punished.

Actually, while Ghrul-Captain had needed to vent some wrath, he could not afford to disable personnel for anything less than outright insubordination. The *Strong Runner* was undercrewed, underweaponed, alone. And his instruments were identifying the stranger as a human warship.

For a heartbeat he glared at the scene in the viewscreens. The target sun was a small disc, its luminance selectively dulled till an extravagant corona was eye-visible. Undimmed, a big world much farther out shone brighter than the true stars. They sprawled in strange constellations—seen at more than thirty light-years from the Father Sun and well off the galactic plane. The Ice River itself looked slightly different, against the background blackness of space.

His gaze focused on the meters and readouts before him, and then on the image a computer program was constructing. He had been taught to know that lean shape, those rakish lines of gun turrets and launch tubes. A lancer, a light naval vessel but easily able to annihilate this wretched carrier. It was about five million kilometers off, adjusting its vectors with an acceleration he could merely envy. A proper war craft would have spotted it immediately when it emerged from hyperspace, wherever in this system that had been. Surely it had picked him up then, and set about reducing the gap between.

Ghrul-Captain forced steadiness on himself, as he might have donned a pressure suit too tight for himself. He would have to communicate with the monkeys and offer them no threat. The necessity was foul in his mouth. He could have voice-ordered a beam in the standard band to lock on; instead, his claw stabbed the manual board.

They were obviously awaiting it yonder. In some thirty interminable seconds, the time for electromagnetic waves to go back and forth, his comboard lighted up. He sent a "Ready" signal—make *them* introduce themselves to *him*—and activated the translator program.

The screen came to life with a human face. Those always suggested to him the faces of flayed corpses. "United Nations Navy unit *Samurai* calling kzin vessel," it gabbled, while the translator gave forth decent growls and hisses. "Request conference with your commanding officer."

"I am he," Ghrul-Captain answered. "I will speak to none but your own master." They could kill him, but they could not make him lower himself.

In the time lag, he felt a ventilator breeze stir his hair. It bore a sharp tinge of ozone. But no cleansing thunderstorm was going to break. Not now. Not yet.

The scan switched to another den and another face, dark brown. From its delicate lines and glabrous cheeks, he decided it belonged to a female. *Ruch!* Still, human females were supposed to have as much consciousness as the males, and often held important positions. He must accept the perverted fact and cope with it.

"Captain Indira Lal Bihari, commanding UNN *Samurai*," she was saying. "Our intentions are peaceful. We trust they can remain so."

"Ghrul-Captain, master of *Strong Runner*." He would volunteer no more. If that piqued her, and if he could know it did, he would have won a tiny satisfac-

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tion.

Full lips drew back, upward. Ghrul-Captain had studied many views of human faces but never learned to tell whether a baring of teeth meant amusement, conciliation, or anger. "Apparently you prefer that I take the initiative. Very well. Your people announced they would send an expedition here like us. We were not quite certain of its nature or its timing. I am not much surprised that you arrived first. Kzinti are . . . quick to act; and our preparations have doubtless been more elaborate.

"We have ascertained that you have one large vessel carrying boats and probes. Our basic arrangements are similar. However, this ship has gone in advance of the civilian to make sure all is well, and will remain in her vicinity after rendezvous. I assume you agree it's wise to take precautions against possible contingencies." That smile again. "Do you wish to respond now, or shall I proceed?"

Ghrul-Captain replied "We will not tolerate interference with our undertakings. That includes too close an approach to any unit or work of ours."

While the time lag hummed, Ghrul-Captain considered what else to say. He had better not antagonize her, for he did need information. Fortunately, humans were devoid of true pride.

"None is intended, Ghrul-Captain. Should any of you be in distress, we will gladly give assistance." He lashed his bare pink tail but held his ears up under the insult, realizing it was unwitting: "Otherwise we will keep as separated as feasible. Let us establish a few rules between us to this end. We can begin by spelling out our plans to each other."

"What are yours, then?"

She must have prepared the speech that followed the silence:

"While at hyperspacing distance, our civilian mother ship will unload a disassembled hyperwave transceiver, with radio relays to the inner system, and leave a gang to make it ready. The job should not take long, given their robots. They'll have a boat and rejoin the rest of us when they are done.

"Subject to change as circumstances warrant, the mother ship and escort will take ecliptic orbit around the sun at approximately three-fourths of an astronomical unit. The scientists will make observations from there, but naturally will also dispatch probes and boats on appropriate courses. These will include visits to the stable planets and their satellites, for survey, and landings if closer investigation seems warranted. We propose to notify you in advance of these, as well as any important maneuvers of the ships themselves.

"Early on, the scientists will put three small robotic observatories in polar orbit around the sun, at about the same radius, 120° apart, to keep the inmost planet under constant study from that angle.

"We . . . request . . . noninterference, too. We will always be open to communication with you. Let neither party judge hastily. Correct, Ghrul-Captain?

"This is our basic plan. May I ask what yours is?"

Ghrul-Captain did not answer for a minute or two. First he must overcome his rage. He wanted to scream and leap. But he had nothing to kill, only this phantom of a monkey five million kilometers out of reach. Useless, anyway, for anything but one instant of release, which would bring down his mission and his dreams.

The humiliation, though! Her words had come like one whip-flick after the next. Not that the she-monkey intended it. She was totally insensitive. It never occurred to her how she flaunted those capabilities—a hyperwave station brought along, a swarm of lesser craft, three solar watchposts—before his poor little expedition—wealth and power such as belonged to the race of Heroes, before her rabble overran and robbed them.

There would be a day of justice, a

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night of revenge.

Not for years.

Meanwhile, he remembered, and helped congeal his feelings thereby, meanwhile I may do a deed they cannot and dare not match, to shame them whether they know it or not—*we* will know, at home—and, possibly, bring back a prize they are also unaware of, which may possibly hold within it the making of some mighty weapon for their destruction. Yes, possibly I will.

First he must reach an accommodation with them, at least for immediate purposes. Grand Lord Narr-Souwa and he had developed some ideas about that back on Kzin.

"You may ask," he said, as the stranglehold on his throat slackened. "For the present, I deem it best that my ship take the same orbit as yours, 90° ahead. That should be a safe distance, while leaving you able to communicate with me on short notice when necessary." And for us to keep an eye on you. "You understand that we will dispatch our own lesser craft as we see fit."

He cooled further during the time lag.

Bihari didn't seem to notice how she had been disdained. He didn't want to believe that she had noticed and simply didn't care. "A question, if you please. We have detected activity of yours at a certain satellite of an outer planet. May I inquire what the purpose is?"

"Supply operations," Ghrul-Captain snapped. He would give her no more. Let the monkeys discover the rest as it happened.

She didn't push the matter. Evidently she had been briefed on kzin ways. Or did she have direct experience? Had she fought in the war? Ghrul-Captain almost hoped so. One prefers an enemy for whom one can feel a trifle of respect. "I see. If you don't wish to speak further for the time being, shall we close?"

He replied by cutting off transmission.

5

Tyra had more and more enjoyed her voyage, until near the end. Everyone aboard was an interesting person. While not yet ready to do formal interviews, she took pleasure in cultivating their acquaintance, from Captain Worning on down. She had met some of the half-dozen crew before, but not all, and none of the scientists except Jens Lillebro, a physical chemist at the University of München; the rest were from Earth. Not that the distinction was absolute. Anybody serving on an explorer was necessarily a technician of wide-ranging skills and scientific turn of mind. Thus, the work gang who would assemble the hyperwave unit, engineer Reiner Koch and boat pilots-cum-rockjacks Birgit Eisenberg and Josef Brandt, would be much in demand after they rejoined the ship. Tyra heard many good stories and found ample cause for admiration.

She was oftenest in Craig Raden's company. She preferred to believe there was more on both sides than physical attraction. Of course, that played its part. Among other factors, she was the only woman out of the six with whom anything but the mildest flirtation was possible. Biologist Louise Dalmady made a team with her husband Emil. Stellar astronomer Maria Kivi, middle-aged, kept quiet faith with her husband at home. Planetologist Toyo Takata was young and pretty but, in spite of being as shy as her colleague Verwoort was bluff, made plain that this was her great career opportunity and she wanted no distractions. Matronly mate Lili Deutsch had her own family back on Wunderland and seldom missed a chance to speak of the new grandchild. Pilots Eisenberg and Brandt had for years been a pair in every sense of the word. Once Tyra spied Raden and physicist Ernesto Padilla exchange a wry glance and a rueful grin. Had he first staked his claim on her? Whether or no, he was never offensive, merely fun and fascinating. They played games physical, intellectual, and childish; they listened to music and watched drama and quoted favorite po-

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etry, they explored the ship's wine stock, they joked, they talked.

And talked and talked. He was a magnificent conversationalist, who always made it a two-way thing.

His account of the finding of their destination fascinated her. She knew about spaceborne interferometry—Wunderland had lately embarked on a project to build a set of such instruments and orbit it around Alpha Centauri C—but why had Earth's matchless facilities not identified this situation long ago? He explained in some detail how many other, more obviously exciting ventures were absorbing funds and attention, notably though not exclusively visits to the sites themselves, while the search for additional high-tech civilizations, beyond known space, grew ever more tantalizing. The star they were seeking had of course been catalogued in early times, but nothing further. It appeared completely ordinary, obscure in its remote location. Finally a slight spectral flutter, noticed in the course of a systematic survey of that region, betrayed it.

How had this given data enough to show not only what was happening, but when the climax would come? Raden had a gift for making analytical techniques clear to a nonmathematician. The precision awed her.

"Well, there's a significant probable error," he admitted. "We'll be getting there none too soon, possibly a little too late for the actual event. Let's hope not! Sheer luck, making this discovery just when we did. True, it isn't unique, but to have one within our own lifetimes, at an accessible distance—" He laughed. "We live right, I suppose."

The last weekly dance of the trip became an especially gleeful occasion. The gym was festooned with homemade decorations. Champagne sparkled on a sideboard. Every woman joined in, with no lack of partners, while music lilted from the speakers. Best for Tyra was when she and Craig were together. She was a good dancer; he was superb.

The hour was late when he saw her to the compartment known as her stateroom. They paused at the door, alone in the passageway. He took both her hands. "It's been wonderful," he murmured. "Throughout."

"Yes." She felt the blood in her face and her pulse.

"It needn't end immediately, you know."

"We have three daycycles left."

"Once I'd have thought that was three too many. Now it's far too few." He stepped close and laid arms around her waist. "Tyra, we do have them. Beginning this nightwatch."

Not altogether surprised, she slipped free with a motion learned in a dojo and drew back a pace. Though her heart thudded, she was able to look into his eyes and say quite steadily, "I'm sorry, Craig. I like you very much, but I don't do casual."

Robert Saxtorph thinks I do, wrenched within her. I had to make him think that, didn't I? After I saw I had no right to ruin his marriage. The kindest way—make it not too hard for him to let go—wasn't it? Wasn't it?

"We don't have to stay casual, Tyra," Raden said. "I'm hoping we don't."

He could be lying. She recalled his reputation. Or he could be sincere . . . temporarily. Or if he really meant it, or if there was a chance he might come to mean it, still, the gulf between them was interstellar. Not easily or surely bridged. Nevertheless—"Let me think, Craig. We'll have time, also at the star and on the voyage back. We'll stay friends at least. Won't we?"

He nodded. "At least," he answered low, with a smile. "Goodnight, then, dear." He leaned across, kissed her gently on the lips, and departed.

She stood for a moment staring after him. He knew better than to insist, tumbled through her. A gentleman, as well as everything else. Suppose he had kept trying—

Memory stabbed her again. Perhaps

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that was why she went to her bunk bewildered.

She slept poorly and awoke feeling on edge. At breakfast in the saloon she ate skimpily, said nothing, and when she was done returned to her room and screened book after book. None could hold her. When she went to the gym, it lay hollow and forlorn. Just the same, a workout followed by a shower was refreshing. She came to lunch with an appetite.

Raden was on hand, chatting easily with others. He gave her a smile as if nothing had happened, and brought her into the conversation. Afterward, however, as they were going out, he came alongside and asked, "Can we talk a bit?"

"What about?" Her voice sounded ragged in her ears.

He shrugged. "Anything you like. If I upset you, I'm terribly sorry and want to make amends."

So he had read her mood in spite of her effort to seem her usual self. "No, I'm not upset, not offended." She managed to give him back his smile. "A compliment, really, and if I couldn't accept, I did appreciate." How honest was she? She didn't know.

He took her elbow. "Look, it's early in the watch for a drink, but on that account we should have the wardroom to ourselves. No harm in nursing a beer. Can we sit down and simply talk? I promise not to go importunate on you."

It wasn't possible to refuse, was it? She liked the idea, didn't she?

Yet she must work to keep from showing her tension. To gaze across the table into his handsomeness reawakened the old pain and whetted it. She'd laid it aside, she'd actually been happy, now she must start over.

Self-pity wasn't in her nature. Resentment took its place. Oh, she had more sense than to blame him. He'd had no way of knowing what a nerve he touched. For that matter, she hadn't known it was still so raw. To rail at dice that fell wrong was idiotic. However, the anger had to strike at something.

"Yes, we'll be busier than a one-armed octopus," he was saying. "Perhaps with the kzinti too."

"God, I hope not!" burst from her.

"I'm hoping for it, actually. I'll see what I can do toward bringing it about, in whatever degree."

Startled, she asked, "What?"

"We might manage some scientific collaboration. You know how fruitful, how inspiring and stimulating, our exchanges with other races have been," he said earnestly. "We're overdue for an interaction with the kzinti that isn't hostile."

"How?" demanded scorn.

He raised his brows. "How not? They're intelligent, sentient beings. Their civilization surely has its own riches. What might we learn from them?"

"New ways of murder and torture, maybe," she sneered.

"You can't be serious, Tyra. Yes, they've been aggressors, they've committed atrocities, but that's been true of humans in the past. Read your history. Nor have we lost the potential, I'm afraid." He gulped from his stein. "Blood guilt is one of the most vile and dangerous concepts our race ever came up with. We've got to put it behind us, for decency's sake, for survival's sake."

She unclenched her teeth. "I'm not talking about inherited guilt. I'm talking about inherited drives and instincts. The kzinti are what they are. You can no more deal with them in good faith than you can with a—a disease germ."

"They live among us, Tyra!" he protested.

"A few. In their enclaves. Eccentrics, misfits, atypical—abnormal, for kzinti. But don't ever turn your back on one."

His whisper sounded aghast. "I didn't imagine you were a racist."

"I didn't imagine you were an utter fool." The flare damped down. "Craig, I *know* them. I grew up under their occupation. I saw what they did to my people. I *felt* what they did to—my father,

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my family—" The tears stung. She blinked them away. "And then I myself—but that doesn't matter. They tried their best to kill my friends and me, that's all. What does matter is how often they've succeeded with others."

"Culture—ethnic character is mutable. It can grow in the right directions."

"When enough of their most murderous are dead, out of their gene pool, maybe then," she said. "You and I won't live to see the day, if it ever comes. And first the weeding has to be done."

"This is appalling." Raden sighed. "Well, evidently the attitude is a common one. We'd better drop the subject."

"Yes," she said coldly. She knocked back her beer and rose. "Thank you for the drink." She left him.

The relationship continued amicable, but warmth had gone out of it.

6

While *Freuchen* accelerated sunward, the first observer probes shot forth from her and began transmitting their readings and images. When a synthesis of the sights was ready, everyone aboard crowded into the wardroom to see it on the big screen. Excitement swiftly became awe.

In itself the star was nothing unusual, a type G dwarf. It had formed from the primordial cloud only about a billion years ago, and as yet shone with only about 65 percent the luminosity of Sol or half that of Alpha Centauri A—fierce enough! Though not naked-eye visible, material was still raining into it in vast quantities. Optical programs, selectively and suitably taming fieriness, showed it wildly turbulent. Spots swirled in flocks, flares and prominences fountained, corona shimmered as far as a million kilometers outward.

Six planets went about it in eccentric orbits. The inmost would not survive much longer.

It had formed at a distance where the growth of a gas giant was possible, and it became one in truth, a mass of ten Jupiters. But already the unbalanced gravitational forces of an irregularly distributed proto-system had been spiraling it inward. Its pull on itself remained so strong that it lost little or nothing as it neared the sun and temperatures soared. The atmosphere distended, though, until now an ovoid 280,000 kilometers long glowed furnace hot, chaotic with storms that could have swallowed Earth or Wunderland whole. Friction with the thick interplanetary medium had almost circularized its path, and worked together with resonances to make this ever shorter. Stripped of moons, it raced through the coronal fringes a million kilometers from the stellar photosphere, around in eleven and a half hours, each time faster and faster. Rotation had been slowed by the huge tidal bulges until cloud-whorls needed fifteen hours to face out to the dark again.

Such were the facts and figures. The reality was roiling, seething, terrible magnificence. It was as if the bloodbeat in the ears of humans struck dumb by the sight faintly echoed those surfs, eruptions, hurricanes, and violences.

After many minutes of silence, Raden said very quietly, "Yes, our luck has held, barely. I got the latest computation earlier this watch. The planet's practically at the Roche limit. It's due to start breaking up."

"When?" asked Captain Worning.

"Not quite certain. Maybe as soon as two weeks, maybe as much as five or six. What will happen then and how—we don't have an adequate model to predict. We need more data, endless data."

"What we also need is names for those . . . bodies," said Lili Deutsch. "Catalogue numbers are too unhandy and hard to remember."

"Yes," agreed Toyo Takata. "And they are a mockery of this." She shivered. "It is not well to mock the elemental powers."

She's not superstitious, thought Tyra.

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She's right.

"Some of us have been talking about that," put in Ernesto Padilla. "What of Hell for the star and Lucifer for the planet?"

"No," replied Maria Kivi. "Lucifer brought his fate on himself."

Words, words, a shield against the overwhelming mightiness yonder. Tyra raised a hand. Eyes turned toward her; she seemed to feel the touch of Raden's. "I have been thinking too," she ventured. "I—I suggest Pele and Kumukahi."

"Who the devil would they be?" barked Marcus Hauptmann.

"From Hawaii on Earth," Tyra told them. "A myth they remember there. Pele was the volcano goddess. Kumukahi was a young chief who unwittingly insulted her. She destroyed him."

Kamehameha Ryan had related it, back in Saxtorph's *Rover*. She had tried to keep him out of her mind. Through no fault of his own, memories of him hurt. Maybe that was why this came back to her in a sleepless nightwatch two daycycles ago.

"Splendid!" Raden exclaimed. "Perfect! You'll know names for the other planets too, won't you? Thanks a thousandfold."

"I don't remember much more. Not enough to go around, certainly."

Takata said, "But I can supply some. I have family in Hawaii, and works on folklore they sent me are in my personal database."

"M-m, well, all right by me, but not official," Worning rumbled.

"Leave that to the officials. I'll undertake to overbear them if they get stuffy." Raden carried the rest along on the tide of his enthusiasm.

As if this really mattered, Tyra thought. Oh, it does, in a way, but that much? To him?

Because it came from me?

Congratulations surrounded her. Raden beamed and waved above the heads. "We'll have a drink on that, Tyra, as soon as may be," he called.

I'm forgiven, she thought. Not that I suppose he was ever angry with me, just with my attitude. . . . The anger was mainly mine, and unreasonable.

He's not going to let me stand aside from him if he can help it.

The knowledge was at once a gladness and an alarm signal.

Raden turned to the captain. "I'll take the boat out for a closer, personal look tomorrow."

"What?" protested Worning. "We won't be in our orbit yet."

"She has delta vee to burn. Not that I'll waste any."

"She's our one auxiliary until the hyperwave gang rejoins us."

"*Samurai* will be close, with several, in case of emergency. Which is ridiculously improbable. And you know I'm a qualified pilot."

"Why, however, when our probes are not even all deployed?"

"Precisely for that reason. A live brain, a trained eye, alert for the unforeseeable. Which, at present, is virtually everything in and around Kumukahi. I'll wager you a month's pay we'll be rewriting the robots' programs immediately after my first excursion."

Worning scowled. "I do not take the bet, because I will not allow this. It is reckless."

Affability and persuasiveness flooded over him. "Captain, with due and considerable respect, I beg leave to prove to you that it isn't. Instead, it's the best investment we can make. Time is short. We can't afford to miss a single chance of learning something. It'll never come again."

He'll win, Tyra knew, and go cometing off, laughing for sheer joy. He will return like a knight of old from a joust with giants.

She could well-nigh see plume and pennon flying in the wind of his gallop.

7

She had planned to conduct some in-

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terviews aboard *Samurai*, but it was an astonishment to be invited, virtually bidden, over there just four days after *Freuchen* took orbit. A naval auxiliary with a tight-lipped pilot flitted her quickly across the few hundred klicks between, and she was conducted directly to a communications-outfitted cabin. Captain Bihari sat alone at a desk, confronting a screen live but blank. The door slid shut behind her.

"Be seated," was the brusque greeting. However, when Tyra had taken a chair opposite, the officer said with a grim smile, "This should give you quite an interesting story." The tone was serious. "For my part, I want a responsible outside observer, to report the truth afterward. Already we're having a crisis with the kzin. Please stay where you are and keep silence while I am transmitting. You will note that you can see what goes on but are not in the scanner field. I don't suppose these ones would recognize you and recall the part you played against their kind, but if any of them did, matters could get entirely out of hand. The situation is bad enough without taking the slightest added risk."

"I could have stayed aboard the *Freuchen*, patched in," Tyra said.

Bihari frowned. "Too many others could eavesdrop. I don't call them untrustworthy, but—different people interpret things in different ways, and soon rumors run wild." She sighed. "The political balance on Earth is such that we have to—we have orders to avoid any unnecessary word or action that might conceivably be taken as 'aggressive' or 'provocative.'"

Tyra stiffened. "Really? Well, ma'am, you must decide what is necessary, mustn't you?"

"Yes, and justify it, here and at home. I wouldn't put it past certain parties to claim we falsified our databases. Easy to do, after all."

No, Tyra thought, Craig would never be so paranoid. He simply, genuinely wants peace—what decent human being doesn't?—and believes we can have it if we try. "I see, ma'am. I'm your impartial witness." Is that possible for me? . . . I'll have my opinions, but I won't write lies.

"You've come barely in time. I have commenced conversation,"—again the wolf's grin—"as the diplomats say, with Ghrul-Captain aboard their mother ship. His response to my complaint, as the diplomats would also say, should arrive shortly." Eight or nine minutes either way for radio to travel between the vessels circling Pele.

Dismay: "It's about Birgit and the Dalmadys, isn't it?"

"Who or what else would it be?"

The fact jabbed through Tyra. Eisenberg had piloted a boat carrying the biological team to the third planet, Kama-pua'a. The second was less favorably positioned at present; though the third orbited farther out, it wasn't much more than thirty hours off, at one gee with midpoint turnover. If something unexpected began happening to Kumukahi, which it might at any moment, the boat would be wanted back straightaway. Meanwhile, husband and wife could do science yonder.

"But—they weren't going to land where the kzinti are," Tyra protested.

More remembrance. Kama-pua'a was another giant, with a swarm of moons. The two biggest had thin atmospheres. They were close enough that tidal flexion, as well as whatever internal heat remained, kept them warm enough that life was perhaps, barely, germinating on either or both. Its origins were so various, probably many of the possibilities still unknown. . . . The boat had sent images back, a great spheroid banded with clouds and storms, the craggy surface of Moku-ola ahead, the joyful expectations inboard. . . .

The kzinti had established their bases on the small outer satellite the humans called Poliahu, obviously mostly ice.

"You know and the kzinti know what sensitive instruments can do, especially

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at short ranges like that," Bihari said. "Frankly, I would have liked very much to send some of ours along, but my orders—hold."

The screen filled with a tigerish countenance. The voice rumbled with a menace and—glee?—that the flat English of the translator had no need to convey. "Your words are insolent. No Hero can tolerate such. You will make amends for the intrusion, amends which I will specify, or your spies will suffer the consequences that they have earned."

Bihari kept her tone level, steeliness only in the dark face. "I deny again that they are spies and that your gang had any right whatsoever to seize them. They will be returned promptly, unharmed, or there will indeed be consequences. However, as a point of information, what demands have you in mind?"

She ceased transmission pending the reply, turned to Tyra, and said, "This is preposterous, as I think even a kzin must realize. They can scarcely be carrying on military work there."

"No," Tyra answered. "Not exactly. I can guess what it is."

"Tell me."

"They used a special kind of tug at the old red sun where Captain Saxtorph surprised them. It could fly close, to nudge ferriferous objects into trajectories for collection. The crew survived those passages because the craft, besides having big reflecting surfaces, was heavily loaded with water. Vented to space, the water cooled it during the time of exposure. I think these kzinti have one like it along, though it must be smaller."

Bihari nodded. "Yes, of course I remember the reports, but thank you for reminding me." She stroked her chin. "Our own long-range observations do show large excavations, and structures that may well be prefabricated facilities for purification and transfer. . . . Yes, I feel sure you are right. Thank you again. You have done us a service."

Our instruments are all directed at Pele and Kumukahi, Tyra thought. "They can't claim that's military."

"Not logically. If it were, it would be a violation of the peace treaty. But—proprietary processes—I can't predict how an Earthside court would rule. I suspect dear Ghrul-Captain was rather well briefed before he left home. The kzin may be mad, but they are not stupid; and . . . there have been humans eager to inform them. There doubtless still are."

"Civilian, military, no difference to them anyway," said Tyra with a bitterness that the memory of her brother redoubled.

"You understand."

"He's been on the lurk for an excuse, any excuse, to make trouble for us. What can we do?"

"That will be seen," said Bihari.

They spoke little more but sat each with her thoughts until the kzin face came back.

"Your two ships will move to hyperspacing distance," stated Ghrul-Captain. "When they have done so, we will allow the three creatures we hold to rendezvous with you. You will then depart."

"And leave further discoveries to you," Bihari retorted. "Sir, you know how underequipped you are. Priceless knowledge will be lost, which it is our mission to obtain." She paused. "Very well, you have made your—initial offer, shall we say? Mine is that you release our people and their boat immediately, unconditionally, and unharmed. In return, we will consider this a misunderstanding which, fortunately, was resolved by mutual reasonableness. I expect your decision as quickly as transmission lag allows."

The screen blanked.

"What next, ma'am?" Tyra whispered.

"We have about a quarter of an hour. Ample time." Bihari activated an intercom and ordered battle stations. Tyra heard running feet and clashing metal. In minutes, a monitor screen showed assault boats leaping from their bays,

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spearlike athwart the stars.

It thrilled in her. Yet what would Craig think?

When Ghrul-Captain's image reappeared, he must have known what his radars and other detectors were revealing. Tyra wondered whether that smoothed his arrogance a little. It certainly did not quell him. "If you do not wish me to send the command for the execution of your agents, you will not try my patience further. I make this much concession in the interests of peace. You will turn your hyperwave transmitter over to us, with complete instructions for its use. I am prepared to consider that a barely sufficient atonement."

Yes, Tyra thought at him, and after that you can do anything you think you might get away with. You aren't armed like us, but—Robert wiped out your red-sun base by crashing an asteroid on it. Your ice tug? I don't know. But I can hear that you don't gag on words like "peace." Was this what you were after all along?

"Ghrul-Captain," said Bihari glacially, "what I will consider barely sufficient atonement is the liberty of our people. My command is in attack mode, as I trust your instruments have verified for you. If we do not hear from those people in minimum transmission time that they are coming safely back to us, we will destroy you. Yes, they will die too, but a Hero understands what honor demands. I require your immediate response."

Blankness.

"Whew!" gasped Tyra.

"Now the burden falls on you," Bihari told her gravely.

"What? How?"

"To make them see at home that this has been the only way."

"But, but, you may lose your whole career—"

"Much worse, the movement for preparedness and a firm stance will suffer. And so a new war will become all the more likely. I think you can help make that clear to the human race. Will you?"

"I'll t-try my damnedest," Tyra promised. Whatever it may cause between Craig and me.

Bihari smiled. "I haven't misjudged you. Nor do I think I have underestimated you."

They waited in silence, together.

Ghrul-Captain snarled while the translator gave: "So be it, then. To treat with your hysteria would be unworthy of Heroes. Your wretched slinkers may return to you, and good riddance. But beware of coming near that planet again."

Bihari nodded. "We grant you that. The third planet will be off limits for us, within a ten-million-kilometer radius. Please note that nothing else in the system, except your vessels, will be. Let this agreement be made in full honor, and our original terms of relationship continue in force. As soon as I learn that our people are bound back unharmed, I will take my command off battle footing. Please acknowledge."

The screen blanked anew.

Tyra felt and smelled that she had been sweating. A chill passed through her. Fire followed. "That was wonderful!" she cried.

Bihari smiled as if unperturbed. "Thank you. They'll be nearly out of their skins with rage, driven to do something or other showing they actually are superior to the monkeys. Let us hope it won't be too dangerous—to us, at any rate." She leaned forward. "I also hope, and I believe you can, when you tell the story, you will soften it, make it seem as minor an incident as possible."

"Yes," Tyra murmured, "that would be best, wouldn't it?"

8

Every deployed robot and observatory, every probe, each of the boats when sent forth, transmitted continuously back to *Freuchen*. The computers printed ever-changing displays and images. Aboard, Tyra could follow moment by

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moment.

"Yes," opined planetologist Verwoort. "The catastrophe will begin any day now."

Kumukahi writhed, distorted and in torment. The night side flickered with enormous lightnings, shimmered with their glare cast back from roiling clouds the size of Earth or greater, flashed with the red sparks of explosions, or whatever it was going on in the upper atmosphere, all above a dull glow of sheer heat. The dayside seemed afire. Bursts of incandescent gas leaped from it like flames. Some broke free and whirled off, vanishing as they dissipated, toward the sun. Storms mightier than Jupiter's Red Spot, and perhaps of greater age, fought to keep their structure as they poured along the steepening slope of the inner tidal bulge. A segment of Pele's disc, dimmed by the imagers to seething purple, filled the right edge of the big screen.

"The spectrum grows more and more strange," said his colleague Takata. "In the past few hours I have been finding an increase of iron, largely hydrides—" Her voice trailed off.

"Spewed up from below, I suppose," suggested the physicist Padilla. "Should heavy elements not have sunk to form a core?"

"No," answered Verwoort. "They exist, yes, and they would be more plentiful in lower layers, but with as vast a mass of hydrogen and helium as this, the percentage is so small that it must always have been diffused. The core is metallic hydrogen, maybe pressed into a still denser form than in Jupiter. This upwelling should tell us much about the gaseous atmosphere."

"It is not the only peculiar chemistry," Takata said. "Jens will have plenty to consider when he gets back."

"What will we see when the whole thing breaks apart, before it falls into the sun?" asked the steward Hauptmann. While he was intelligent enough, science was not his forte, and with as many people to look after as there were on this voyage, he had been too busy to keep track.

Kivi shook her head. "It won't break like a melon," she explained. "The planet's self-gravity will hold it together as it fills its Roche lobe. We can't predict events with any precision, and no doubt we will be surprised. However, we can say that turbulence within may well eject great gouts of material, forming a spiral that streams into the star. The magnetic effects—but that goes too far into speculation. Eventually the planet will take a teardrop shape, filling its Roche lobe, and pouring its substance down that spiral until it becomes an accretion disk. This will go on at an accelerating rate for some undetermined time. Decades at least, possibly centuries." She sighed. "How I wish we had probes that could observe from sunside!"

A goodly number were aflight, but those that had gone between planet and star were suicides, sending only bare glimpses before heat and radiation killed their electronics. Tyra's mind strayed for a moment to an image she had seen two daywatches ago. *Samurai*'s long-range observations had, earlier, picked up a craft that emerged from *Strong Runner* and went out to the ice moon of Three. Now it had returned, presumably loaded. Spheroidal, with broad fins, blinding-bright reflective, it was of a size to account for the mothership apparently having only three other boats along in spite of being designed as a carrier. The view that *Samurai*'s computer reconstructed and shared with *Freuchen* showed it maneuvering about, a test run. Spectroscopy revealed it venting some water vapor widely over its surface.

Craig Roden had been with her then, gazing as intently. "A sundiver for certain," she had said. "Not nearly as big as the one Captain Saxtorph encountered, and probably not as well outfitted. It can't have life-support for more than

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one or two. A prototype, pressed into service."

"You seem to have studied the subject rather thoroughly," he drawled.

She felt how she flushed. "Naturally, after I'd been with *Rover*'s people, I was interested in their past experiences and went back to the database entries."

Was he watching her? She didn't look toward him. "For an opportunity like this, they'll take the risk. A bold venture, ingeniously thought out, and very possibly scientifically invaluable. We *must* find our way to cooperation with them."

She made no reply. Worse than useless, reviving that quarrel. He had likewise been careful after the crisis to say merely that Bihari could have shown more restraint. After all, Emil, Louise, and Birgit were back among them, uninjured albeit shaken. Once again, though, the relationship between Tyra and Craig was not quite cordial. That hurt worse than she cared to admit.

Kumukahi's image was slipping close to Pele's in its headlong rush around the sun.

"The polar orbiters are doing fine work," Takata was saying.

"At a distance," Kivi answered. "If we had had time to design and build a sundiver of our own—"

"We didn't," snorted Verwoort. "We can recommend the making and dispatching of several when we report home."

"Robots," said mate Deutsch a bit sadly. "Nothing but robots to keep watch after us."

"Well, replied Captain Worning, "decades or centuries would be a long and expensive time to maintain humans on station. They might grow bored."

Padilla laughed. "Besides," he put in, "when enough atmosphere is gone that the core drops below a critical threshold, it will explode. *I* would not want to be any closer than hyperspace escape distance."

"Yes," agreed engineer Koch, "better we live to see the images."

Kumukahi dropped below yonder restless horizon.

"Let us check with the boat," proposed Worning, and entered a command. Tyra's heart stumbled.

Josef Brandt was piloting for physical chemist Jens Lillebro. Raden had invited himself along. "Not my cup of tea, strictly speaking," he had said with his irresistible smile. "But one never knows what sort of clue lies where, does one? At least I can take a few observations of Pele from that angle. Those spots on her are acting downright eerily," as the planet's gravitational force swept through the photosphere.

The screen in *Freuchen* awoke again, to a view of *Henrietta Leavitt*'s cabin. Brandt sat intent at his controls, Lillebro at his spectroscopic readouts. Raden saw that they were in communication and responded. "All's well," he proclaimed. "We're closing in on the asteroid, and will have velocities matched quite shortly, at about five klicks' distance. Behold."

No time lag was noticeable. They were only some 15,000 kilometers away. Kivi had identified the body among the data pouring in from the continuous automatic sky-scan and, retrieving earlier information, computed an orbit. Now they saw a rough gray lump, about three kilometers long and one at maximum thickness, slowly tumbling.

"Apparently chondritic," commented Raden. "You'll notice the remarkable sparsity of craters. You're right, Maria, it must be from the outer belt, lately perturbed into an eccentric path."

Pristine, Tyra knew, formed hardly more than a billion years ago, in a thinly-bestrewn region where there had been scant occasion or time for collisions. Probes were to examine such rocks later. But who knew how much later? Composition and structure might well give unique insights into the early life of every planetary system. This chance was too good to pass up. Should Kumukahi make sudden call on *Henrietta*, she

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could boost back to *Freuchen* in well under an hour.

"Backing down on it, essentially," continued Raden's voice. The asteroid swelled fast in sight. "As you recall, we'll run parallel and let Jens stare while we send minisamplers—"

The thing erupted. A white cloud burst raggedly forth. Gravel and boulders sleeted outward.

Tyra heard herself scream.

The view swung wildly. The barrage became glints across a whirl of stars. Somebody in the boat yelled, "*Almächtige Gott!*" Somebody else ripped an oath.

The view returned to the cabin and steadied on Raden. Sweat studded his brow, but he grinned, well-nigh laughed. "Whoop, that was close! Thank Josef here. The autopilot isn't programmed for—he yanked us free. Barely, but he did it."

Brandt looked around, his own expression grim. "Barely is correct," he grated. "Some of those stones could have holed us, or even been bouncers."

Tyra shuddered. She knew what he meant. The boat lacked a protective screen-field. The hull was self-sealing. But a small object that punched through could lose too much energy thereby to make an exit, not too much to ricochet back and forth and quite likely hit a man.

"*Was für den Teufel*—what happened?" roared Worning.

Lillebro spoke almost calmly. "I can guess. The chondrules surrounded a mixture of ices, which also mortared them together. The agglomerate was metastable, and the impulses from our polarizer drive as we neared touched off volatilization and—it will be fascinating to learn what reactions."

"A bomb," added Raden. "I daresay they're not uncommon in young systems, but all of them are disrupted—solar input, impact energy, perhaps cumulative cosmic ray effects—long before intelligence evolves locally to notice them. What a discovery!"

"It has just begun," said Lillebro with rising excitement. "The gas spectrum, and we'll collect specimens—"

"No," decreed Worning. "You will return here. At once."

"What? But, sir, now that we're aware—"

"Of what are we still unaware? I will not risk one of our two boats and three of our lives for something that robots can examine at leisure. Return. That is an order."

"Yes, sir." Brandt did not sound unwilling. Lillebro sighed. Raden gave a wry grin and a rueful shrug.

When he cycled aboard, Tyra was waiting at the lock. She reached for his hands. "You might have been killed," she stammered, and could not altogether hold back the tears. "You might have been killed:"

He drew her to him. "Do you care that much?" he whispered. "I dared not hope."

9

A bunk could be folded out to double width, though it then filled most of the deck space in a so-called stateroom. Lights could be turned down to softness. Music could be commanded, *Là ci darem la mano*, *Liebestod*, afterward the lilt and gentleness of *Fynsk Foraar*, though likewise softened to a background.

"That was amazing," he said as low. "I didn't quite expect a supernova."

"Thank you," she answered, snuggling, refusing to wonder if he'd used those words before or how often. "Same order of magnitude to you, sir. But let's settle for ordinary novas. They can repeat."

He chuckled. His lips brushed her cheek. "Shameless hussy."

"I'd better be. You too. How many bets will be paid off tomorrow?"

He looked away. She heard the sudden seriousness. "You told me you . . . don't do casual."

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She confronted her own spirit. "I don't."

"It's far too early to make promises. On either side."

"I realize that. But I decided, nothing ventured, nothing gained." And, if this didn't last—certainly the obstacles were many—she would at least have a profit of memories. As he would; she'd see to that. And she had the strength to pay the price. Which maybe wouldn't be required of her.

His eyes met hers. "I'm being as honest as I'm able," he said, "because in fact I am in love with you."

"All right, it's mutual."

"I wish I could, well, give you more. Now, I mean, before we go . . . home. We have so little here."

Through the eased-off happiness she felt her mind sharpen. She had given thought to this too. She did not believe the idea had snapped the leash she kept on herself. His escape did that. Nor was it a price she set, a bargain she struck.

Nevertheless—

"You can," she said.

His head lifted off the pillow. "What?"

She moved slightly aside from his warmth and male odor to lean on an elbow and keep hold of his gaze. "When Kumukahi begins breaking up, you'll be out there to watch, won't you?"

"Of course. We haven't that many free machines, and we don't know enough to write adequate programs for any. Who can tell what human observers might catch?"

"Take me along."

"Eh?" he exclaimed, and sat straight. After a moment, he leaned back. "No, really, darling, it's not feasible. If the event begins in the next few days, and it probably will, Birgit won't yet be fit to pilot. That leaves Josef for one boat, crammed with scientists and their gear."

Tyra nodded. "I know," from what *Rover's* crew had told her. Neither they nor Eisenberg were weaklings, but kzinti captivity was at best unnerving. Given a stiff enough emergency, you could force yourself to carry on for a while. Thereafter medications merely helped time and nature. Eisenberg was absolutely right to disqualify herself for another week or two.

"And autopilot won't do for the other, not when we are bound to be surprised and must react fast if we are to collect the data," Raden went on. "I shall have to steer." Even now, she heard the relish.

"Exactly," Tyra said. "In that case, you can pick who comes with you, can't you? If you make a point of it."

"Well, I see where it could give you a spectacular story. But no, the hazard—No."

"What hazard?" she challenged. "You're skilled, you're not a fool, you won't take unnecessary risks."

"Not knowingly. Still, who can foresee what happens?"

"Who can foresee what will happen anywhere?" She moved back to his side and laid an arm around his neck. "Yes, I may get quite an eyewitness account, but that doesn't matter, Craig, truly it doesn't. This," she crooned, "is something you can give me, because it's something splendid we can share."

She was entirely whole-hearted and honest. Well, almost.

Her free hand roved. She knew she could persuade him.

10

The three ranking kzinti met for their last time in the command lair of *Strong Runner*.

"Once more, master, I ask that you reconsider, and take me with you," said Rach-Scientist.

Ghrul-Captain growled negation. "And once more I tell you that you are wanted to oversee what other data collection this expedition can do, and bring the booty safely home, whatever may become of me. You have been less than enthusiastic about my plan. Do you challenge my decision?"

Rach-Scientist slipped his tail briefly between his hocks. "No, master, as-

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suredly not."

Ghrul-Captain relented. "Bear in mind, this is a trial run, the first severe one. Yes, the instruments will peer and snuff, but foremost is to prove that the vessel can run such a course. That ride is for me alone." And for me alone the glory, and the triumph that it will be over the monkeys, he thought; it was as if he tasted fresh blood. "On later flights, yes, perhaps I will let you come, too."

"Master, I have not questioned your wisdom, nor do I now," said Shayin-Mate. "However, I venture to ask that you record a summary of your intent. Should anything go awry, against my wishes—"

Then you will be acting captain, who takes the ship back, makes trophy of the prestige that that confers, and contrives to lay the full blame for the debacle with the monkeys on me, thought Ghrul-Captain sardonically. Not altogether against your wishes.

He did not resent it. In the mate's position, he would have done the same.

His rage at the humans flared. Because of their contumely, the exploit ahead of him would merely win back the standing Ress-Chiuu had lost for him. No net advancement. Unless, of course, he could do the foe a real injury. . . .

"The lords at Kzin will want a quick overview of events," Shayin-Mate went on. "The technical reports can be digested for them later."

Ghrul-Captain's fury smoldered back down. He expanded the ears he had folded and gibed, "Since you feel yourself incapable, I will pace the track for you."

"Master, it is simply that your own words will have the most force. I hope with all my entrails you will be on hand to deliver them personally."

"So be it." Ghrul-Captain set the intercom scanner to record. Having curtly stated the purpose, he declared:

"I am about to take the sundiver *Firehunter* on a swing around the sunward side of the giant planet we have come to spy out. The planet has just commenced its death struggle, so this is urgent. How things will go is unpredictable; they may become too violent for another such flight, although I am ready to dare whatever looks possible. For the same reason, unforeseeability, I make the flight piloted rather than robotic." As well as there being no honor in risking a few machines. "I will accelerate inward, cut the drive at a suitable point, and have the planet itself take me around. I will then be moving at high velocity on a hyperbolic orbit which, if allowed to continue, would carry me nearer the human ships than is . . . desirable. However, well before then, I will reduce the vector and start acceleration on a quartering path to rendezvous with *Strong Runner*. Available delta vee is ample.

"Perhaps observation of these extreme conditions at that close range will yield data of military value. It is sure that nothing like my mission has ever been attempted before.

"Glory to the race!"

He switched off and looked straight at Shayin-Mate. "Will that do?" he asked: a sarcasm, for it had better.

The other dropped his gaze. "Thanks and honor to our captain."

Rach-Scientist said nothing. En route he had expressed doubts about the utility of the scheme. The passage between star and planet would take less than four hours. What few instruments could endure the environment must be rugged, heavily shielded, basically simple, and therefore of very limited capabilities. His class was necessarily allowed a certain latitude, and Ghrul-Captain had been content to override his objections. But to pursue them, especially now, would be insolence meriting punishment.

And, yes, in the end he wanted to fare along. He too was a kzin.

"I go, then," said Ghrul-Captain. To linger when the game was afoot did not become a Hero.

He strode down passageways and sprang down companionways to the

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portside boat lock. *Firehunter* waited alongside. A guard made obeisance as he reached the gang tube between. He passed on.

The control den, the only section of the vessel with life support, was a hemispherical space less than five meters across, crammed with equipment and storage lockers, just enough room free for a kzin to curl up on a pad and get a little sleep—hardly a fit prison cell. The air hung chill and stale-smelling. Yet in the viewscreen above the main control panel blazed his goal. He exulted while he settled into the command seat, activated the systems, heard the purr of power and felt the slight tug on him when his craft cast free.

Heavily burdened with her surrounding shell of water, she could not accelerate as fiercely as he would have wished. But her speed did mount, second by second, sunward bound. Ghrul-Captain hissed his satisfaction.

11

Tyra and Craig would be alone aboard *Caroline Herschel*. They could take several days, perhaps as much as a week, depending on what they found. "Not long enough," he grumbled, "not by half. Well, I'll come back, make better arrangements, and set forth again."

"I don't think this arrangement is a bad one," Tyra purred.

He laughed. "Nor do I. But the idea *is* to do science."

"Don't worry, dear, I won't get in the way. Not of the science, at least. Remember, I'm supposed to report it. We won't be tied down twenty-four hours per daycycle, though, will we?"

"M-m, no. The instruments will generally operate themselves. I'm basically to oversee, and make decisions when the inevitable surprises jump at us. Otherwise . . . we'll often sit goggle-eyed, I'm sure. But no, not the whole time."

"Don't worry," she said demurely. "Some happenings won't be reported."

She could not have been accommodated in *Henrietta Leavitt*, in any case. That boat would be crowded with scientists and their equipment. The Dalmadys did best to stay aboard *Freuchen*, working up what results they had obtained so far. Likewise, Padilla was fully occupied with the data flooding in from probes and observatories. Verwoort remained also, having lost a coin toss with Takata; it was unwise to send both planetologists together, and he'd have more than enough to keep him busy.

Henrietta departed in the prograde direction, boosting to a path that would take her as far sunward as was deemed safe. A boat from *Samurai* went along, just in case, and to keep a better eye on the kzin mother ship, orbiting ninety degrees ahead of her. Mainly, Bihari wanted her to follow the progress of the sundiver lately detected on a course for Pele itself. Furthermore, the navy craft had capabilities that would be substantially helpful to the scientists.

None accompanied *Caroline*. She was going retrograde, to study from a different angle what happened in the star rather than to the planet. The only kzin vessel she would see, and that from a considerable distance, was the sundiver when it swung half around Kumukahi and came out of the glare on a hurtling hyperbolic trajectory. Carrying two people, the boat could readily hold everything Raden needed for his work.

She even offered some extra space. He came upon Tyra when she was stowing a portable cooker-washer, kitchenware, tableware, and assorted things to eat. "What the deuce?" he asked.

She grinned. "I'll have more leisure to spare than you," she explained. "I want to show you I can cook, too. I wheedled Marcus out of this—yes, the chill cabinet has room for it—and we'll have beer and wine as well. No need for us to pig it on dry rations and recycled water." She sighed. "Alas, no candles available."

"Well, we can turn the lighting way low—"

"Or block off the sun. Simply the

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stars. . . . No, maybe that's best for later."

He cocked his head at her. "D'you know, you're the damnedest combination of the romantic and the practical."

"We women have to be."

"And we men get to enjoy it. How I pity the kzinti!"

Thus they took off merrily. The last thing they heard before the airlock closed behind them was Verwoort's bawdy farewell.

The next few days were sheer wonder. Personal joys became not separate, but integral with the whole. Tyra had an educated person's knowledge of science. Fascinated by what Raden told, especially about what was being newly revealed to him, she found that talking with her stimulated his thinking; she actually made a few suggestions that he called excellent. It was happiness merely to see and feel his glee; she could watch him in his preoccupation for hours, as she used to watch the sea at her childhood home or could lose herself in the splendor of open space. However, she seldom indulged idleness. Besides her cuisine and a few other minor things, there was her writing. How to find words for what she beheld, how to tell it? Personal impressions, text for a documentary, background for a novel, a cycle of poems—nothing could ever really capture truth, but the thrill of the quest was upon her.

A hundredth of Pele's mass skimmed around it and had begun to rain down into it. Incandescent tides raged, brewing maelstroms that crashed together and spouted monstrous plasmas; blaze scudded like spindrift; invisibly, magnetic lines twisted around each other till they snapped and energies exploded that dwarfed whatever mortals knew to touch off; the deeper layers roiled, and maybe certain atomic nuclei were fusing in strange ways: mystery, mystery, unfolding in fury.

The sun was not shaken to the core, Raden said. These were transient effects. In the course of the next century or two, they would die down, leaving little other than a slightly changed chemical composition and thereby, perhaps, a main-sequence evolution slightly hastened. Nor was this present chaos quite akin to a storm such as humans knew. However mighty it appeared from afar, it was gases in a soft vacuum. The deadliness lay in the radiation, charged particles, searing infrared, blinding light, lethal X-rays. Heavily protected, a spacecraft *might* still pass quickly through unscathed.

Might. Nobody knew. Nobody before them had been this close to this kind of catastrophe.

Tyra's mind dwelt more on Kumukahi. A planet, no matter how huge and alien, was closer kin to home than any star. Whenever it swung into view and she had the use of the screens, she strained at the magnified image, gripped, half terrified.

Pele had drawn the spheroid into a teardrop, but a living and throbbing one. The extended tip seethed and surged like a monstrous, fluid volcano. Hydrogen-helium smoke poured as from a nozzle, redly and restlessly aglow with fluorescence. It rushed ahead, girdling the planet's slayer with a ring that wound into a spiral whirling ever inward. Sparks and gouts flew free, knots of momentary concentration, like lava bombs. The titanic outpouring shuddered, shifted, ever changeable, spurted lesser eruptions of moon size, wrapped itself in clouds that then boiled away to give sight anew of the cataract streaming upward. Everywhere else churned chaos. All was red, a thousand shades never the same for two instants, from murky roan through carmine to blood damasked with blue-white.

Kumukahi's dying in style! thought Tyra once; and then: That's how Robert would put it.

She dismissed the pain, which had become small, and went back to what she had gained.

* * *

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12

The rage toward which Ghrul-Captain rushed filled heaven. The air in which he crouched recalled to him an equatorial desert on Kzin. An overloaded cooling system gusted and whined. It was time to go into sundiver mode.

Firehunter could have done so automatically. This, though, was his flight. Whether or not any other Hero ever knew, each thing he did raised his honor, was a blow he himself struck at the enemy. He stabbed the manual override. "Hro-o-o!" His roar echoed through his cave.

Steam vented from a thousand pores in the metal shell that enclosed the hull. The optics did not show it to his eyes, but the instruments did. The craft must take care of this for him, sensors gauging moment by moment how much to release. Calculation had shown that, given close control, there should be enough, just enough, to see him through the danger zone—if the calculations and the data upon which they drew were nearly enough correct. He had to trust them as he trusted his weapons. A Hero did.

And he was still the master of the wild hunt ahead. Again the control displays showed him what they would do of themselves and when. He heeded them as he would have heeded the scent of a quarry. But again it was he who cut off the drive.

Now let the planet sling him halfway around itself and cast him forth at more than cometary speed. For those three and a half hours, while the instruments drank down what knowledge they could, he must watch and wait—only that, if all went well. If not, he must choose what to do and do it. Nobody could have programmed for every unforeseeable violence. The fact brought no sense of helplessness. He had the heat to fight, with copious drinks and his own endurance. Meanwhile, he lurked watchful, as if in ambush.

Nevertheless awe came upon him. Under these conditions, optics were altogether inadequate, yet he saw, however partially and blurrily, he felt, he defied.

Firehunter flew between two walls that towered and reached beyond sight, one red-hot, geysering in mountainous lightning-shot clouds, shuddering beneath them until he imagined he could feel the thunders in his bones, the other a white-hot furnace out of which licked crimson tongues of flame. A thin opal haze shimmered everywhere around the spacecraft, fantastically writhing, where long livid arcs leaped and knots exploded into bursts of gigantic sparks. Ghrul-Captain sailed amidst a wreck of the gods.

Over and over again he roared at it, his challenge, his triumph.

A crash smote his hearing. *Firehunter* reeled. The noise became a hailstorm that dashed against metal and rang in his cave.

That smote through!

Ghrul-Captain saw the brief cloud gush out. Immensity swallowed it. An alarm keened. Readouts raced crazily over the pilot panel. Ghrul-Captain knew himself for a warrior suddenly stabbed.

Something had riddled the outer hull. It had not pierced the inner, but the water cells were ruptured and the fluid of life boiling away.

The bombardment ceased. He had passed whatever it was, or it had ended. No matter. It had slain him.

"No!" he bellowed, and snatched for the override. Start the drive. At full boost, he might break free before he baked.

Weightlessness took him, like a falling off an infinite cliff. Lights still shone, ventilation whispered. But nothing responded to his claws. He glared at the panel. The gravity polarizers were dead. He had no thrust.

How? flashed through him. An integrated system, well armored—but the damage to the massive water circulators

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and everything that regulated them, the escape of those tonnes, vibrations, resonances, yes, the plunge in temperature—he was breathing air gone wintry—yes, that could have disrupted critical circuitry. Then safety locks cut in and the fusion generator shut down. Nothing was left him but the energy reserve in the accumulators.

That's as well, he thought starkly. Radiation from reactions running free would have killed me in minutes.

Which would have been better. Easier.

"No!" he snarled. A Hero did not surrender.

He was on trajectory, outward bound. The chilling gave him a short respite before temperature mounted. It might level off, as he receded, before he was cooked dead.

If he survived, it would be an exploit unmatched in history. None could then deny him his birthright, and more, much more.

If not, this remained his deed, wholly and entirely his, which nothing could ever take from him.

13

"Oh-oh," said Raden very softly. "I don't like this *at* all."

Tyra's pulse jumped. "What is it?" Her voice sounded shrill in her ears. It must involve the kzin sundiver. *Freuchen* and *Samurai* were peering with high-tuned instruments, as the thing came out of Pele's blinding glare and deafening plasma. But they were almost two light-minutes farther away than *Caroline* had ventured. They had sent their request that the boat likewise keep watch. Orbiting ahead of them, the kzin mother ship currently had the sun between it and its explorer. Whoever was in command there had not deigned to respond to the human offer to relay information as soon as it was received.

Raden gestured. "Look."

Tyra peered over his shoulder at the viewscreen before which he sat. Magnified, chosen wavelengths dimmed or amplified, the image was hardly more than a schematic. To her eyes, a small segment of Pele was a purple rectangle filling a slice along the left side of the screen. Prominences were tendrils, the corona a ghost-shimmer. A starlike speck gleamed nearby. That must be the best that the boat's sensors could do at this remove, lacking interferometry, she thought almost mechanically. Raden's finger pointed at the displays and readouts beneath the video.

"The spectroscope gives no hint of water molecules or OH," he said starkly. "She ought to be venting yet, to maintain an endurable temperature till she gets clear of the peristellar zone. Instead, the infrared emission is like an oven's, or worse. And doppler shows she isn't boosting to escape. Hyperbolic trajectory, slung off by the planet at terrific speed but not fast enough. Something's gone terribly wrong."

It would be obscene to rejoice. However, Tyra could not find pity in her heart. "What may have happened?" she inquired.

"God knows, at this stage. Close examination ought to give an idea or two." Raden turned his head to stare at her. "Meanwhile, though, the crew are being baked alive!"

"If they haven't already. Or he. Whichever. What do you want to do?"

"Try saving them. Nobody else possibly can."

"How can we?" The figures he had mentioned to her spun through her head. If the sundiver's periapsis grazed through the significant fringe of Kumukahi's distended atmosphere—and what other course would a kzin plot?—the planet had hurled it forth at more than a hundred KPS, far over stellar escape velocity, bound for the stars. . . . But the plan must have been to decelerate till the craft could swing around to rendezvous with its mother.

Raden swiveled about in his seat. His fingers danced across a keyboard. Meanwhile he voice-activated transmission.

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"*Caroline* to *Freuchen* and *Samurai*. By now you'll have seen that sundiver's in trouble. The other kzinti can't match velocities and lay to till long after the ones aboard are dead. I propose to make rendezvous and rescue them if they aren't, yet. If this craft has the capability. That's being checked. Assuming a positive answer, we'll need to skite off immediately. I'll await your response."

Three or four minutes—"Have you gone crazy?" Tyra protested.

He gave her a lopsided grin. "No, in my opinion I'm being more sane than most. If the computations tell me what I hope they will. . . . Ah!" He swung his chair again to stare at the readouts. She stood above him, behind him, helpless, listening to his monotone. "Yes. Just barely feasible. Killing our present vector, boosting to match while approaching, yes, it calls for accelerations up to ten gee. Within stress limits for our craft, though an engineer would probably shake his head a bit. The thermostatic system will be overloaded too, but not overwhelmed if we're quick. And we'll squander energy. We should have enough delta vee left afterward to make it home. If not, the difference by then will be slight, and *Samurai* has a tug plenty well able to meet us and haul us back. We can do it."

Abruptly his tone rang. "Therefore we must."

The comscreen lightened, view split to show two faces. "This is lunacy," growled Worning. "No!" and Bihari, quietly, with her ironic smile: "The kzinti aren't noted for gratitude. My recommendation is a decided negative."

"Ma'am and sir," Raden replied, "let me respectfully remind you that while this vessel is in free space, I'm in command, with discretionary authority. If I'm mistaken, a board of inquiry will pass judgment later. Now I've no time to lose. We're on our way."

He rapped his piloting instructions. In a moment or two the boat left free trajectory. The interior gravity polarizer field kept weight steady under Tyra's feet, but she saw the stars whirl into a new configuration and felt a brief surge of power fully aroused, a shiver in the deck and through her bones.

"Well, you are within your legal rights," Bihari said. "I am not so sure about the moral ones. You understand, do you not, that we can do nothing to help you until much later in this game?"

"And the devil knows how the kzinti will react," added Worning.

"Contact them, of course," Raden answered. "Explain the situation. That I—we—have no intention of more than a rescue attempt, and we'll lay no salvage claims or anything like that. In fact, I promise to leave whatever kind of black box they have, the data this flight gathered, alone, for them to retrieve. Let me suggest you offer them any other help you can give. That's traditional, after all."

He laughed. "Don't worry about us. We're within our safety factors. Quite an adventure!"

He cut off transmission, pending further reception, rose, looked into Tyra's eyes, and reached for her hands. She withheld them.

His smile was gone. "There will be hazards," he said low. "Aren't there always? I rejoiced to have you along, darling, but now I'd sell my chance of having an immortal soul—no, that's too cheap a price—I'd give everything I own for you to be safely back aboard *Freuchen*."

Every material thing, maybe, she thought. The bank accounts, the royalties, the vacation home, the sailboat, whatever. But how could you divest yourself of your reputation, your fame? This deed can only add to them.

Her bitterness shocked her. It wasn't reasonable. Was it? "Well, I'm not there," she said, "nor sorry."

As if to reinforce her, the comscreen brought Worning and Bihari back. "Playing the noble knight may be very well, Raden," Worning snapped. "But you're

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spending the resources of our expedition, and putting critical assets at risk, for no other gain."

"Oh, God, can't you see?" Raden exclaimed. "That's a living, sentient being yonder, maybe two, with a ghastly death ahead of them. Could you stay idle in my circumstances and still call yourself a man? I don't believe that, Captain Worning. I don't believe you would."

This time he left transmission going while he appealed to Tyra. "Nor would you." With a quick, wry grin: "And call yourself a woman. Which you are, incredibly much."

"I think you're confused about the issue," she told him out of the ice within her. "A human being, or a—a dog, yes. Kzinti, no. They're something else."

He seemed appalled. "You can't be serious!"

"Yes, they're as intelligent as we are, in their fashion. Maybe they can feel pain as much, in their fashion. But it doesn't mean the same to them. They have nothing like sympathy, compassion, anything we humans have had such a struggle to keep alive in ourselves. Craig, I've seen what they do. I've *lived* with it."

Dada-man, snatched away from everyone he loved and who loved him. Mother, dying of grief, unjustly disgraced. Ib, betrayed into dishonor. The endless years of the occupation, friends killed, crushed, hunted down like game animals, eaten. The murderous assault at the black hole. . . . And those were merely things she had witnessed or heard of at first hand. She knew of too many more.

She heard the shock: "But this is racism. The old horror. Jews made booty of, Amerindians massacred, Africans enslaved. . . . I grant you, it's a horrible culture, but they can learn better. The Mongols were once the terror of half a world. They became one of the most peaceful people on Earth—"

"If you please," interrupted Bihari, answering Raden's reply to Worning, "I daresay you suppose you're making a goodwill gesture, which will go toward improving relationships. I have my doubts, but since you are on your way and not open to argument, we will communicate with the kzinti, fully and frankly, and stand by to render any assistance we can that they will accept. We will keep you informed. Meanwhile, we shall be on alert status."

"*Ja,*" rumbled Worning. "Good luck. You'll need it."

The images blanked. Neither captain meant to nag, nor would they allow anyone else to stammer best wishes.

"We've got a couple of hours to make ready," Raden said. "First aid, for openers. A very near thing at best. Prepare for unpleasantness, Tyra. A cooked *corpse or . . . worse.*"

"I've known worse."

His expression, stance, voice pleaded. "Do you really feel we're altogether wrong to do this?"

It was not simply that she happened to be with him and got no choice, it was that she *was* with him, for as long as might be. Maybe for life. "No," she made herself say, and confessed inwardly that he did have a certain logic, that without some forthcomingness—which could only begin on the human side—the hatred and slaughter might well go on until one race or the other went extinct. "I'm with you," and now she took his hands and presently returned his kiss before they got busy.

She refrained from wishing aloud that they had a firearm along.

14

"We have still received no response from the kzinti," Bihari reported. "Among other things, that means we don't have the code for opening any of their airlocks. Since you are closing in, I have ordered a naval 'key' program sent you. I suppose you know it directs phased currents through your contact module and analyzes the reaction to each set of pulses. A search pattern con-

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ducted at electronic speed. It ought to determine the unlocking sequence within a few minutes. The program is classified information, but merely at 'confidential' level, and may be shared in emergency. Instructions will accompany it. Prepare to download."

Raden nodded. "I rather expected this," he told Tyra. "I didn't think the captain would leave us to cut our way in with laser torches. Dangerous, as well as slow. No doubt she'll order the program wiped from our database after we return, but actually, one relies more on interstellar distances and infrequent contacts to keep such things from spreading. All colony worlds have similar tools, civilian as well as military, and many spacecraft carry them. You might need to get into a friendly ship, too—a Crashlander, say—when for some reason the crew couldn't just let you in. Or any of all the other unpredictable situations."

He spoke rapidly, dryly, as if he were lecturing to a class. Tyra listened, though she already knew most of it. This must be a way for him to release some tension. Mainly he directed himself toward the keyboard.

Sweat gleamed on his brow. Tyra felt it on her own face and soaking her armpits. She wondered how much of it was due to excitement—fear?—and how much was the body trying to maintain temperature. The compartment, the whole interior had gotten unpleasantly warm, and still the temperature crept upward.

The thermostatics weren't failing; they struggled as best they could against an input for which they weren't intended. *Caroline* had unfolded her extra radiation surfaces, like huge wings, their thinness tilted normal to the swollen sun-disc. Unless you have vapor to release, as the kzin venturer had had, radiation is the single way to shed excess heat in space, and it does not work very fast.

The wings of an angel, speeding on an errand of mercy—Memories arose of themselves in Tyra, childhood, church, the steel steeple of St. Joachim's shining above München . . . during the kzinti occupation, it stood in more human minds than hers as a symbol of freedom, eventual liberation, but you seldom said such things aloud, never where kzinti might hear, because then they would likely tear it down. . . .

Caroline was closing in, sensors at maximum, autopilot adjusting vectors like a high-wire walker. . . . Yes, Wunderlanders had revived quite a few such acts during the war, more often performed for live audiences than cameras, another silent declaration that humans were not cattle. . . .

Optics gave a clear view of the sundiver, massive, ungainly against the stars, but—she must admit—its own sign of indomitability. She could magnify until a single section filled the screen for close study. She saw the holes strewn over the outer hull, small, not really very many, but sufficient to let the water seethe unchecked away. And forward she identified a damaged outercom dish. That explained why there had been no contact on any band. The damage didn't look great to her. Crew could readily have fixed it and regained communication, except that none could venture outside and live to do the work. Could a robot? Kzinti technology seemed to lag others when it came to robotics. Nevertheless—maybe there was no robot, or maybe no person left who was able to dispatch one.

Minute by minute, the image expanded. *Caroline* was closing swiftly in on the reality.

Raden finished at the keyboard, rose, and stretched, seeking to limber muscles too long tautened. "Is the medical care station ready?" he asked. Laying everything out for that had been her job.

"Yes," she snapped.

"I'm sorry. Stupid of me to ask. You're always competent." He sighed. "Not long now. I damn near wish it were.

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Then we could perhaps—But we'd better prepare ourselves."

She gave him a smile.

He did pause to frown at the spacecraft's image. "Quite a bombardment," he muttered. "I doubt it holed the inner hull. I'd expect somewhat different spectroscopic readings in that case, and sheer off right away. As is, all we know is that it's an oven inside there."

They started aft. "Have you any idea what did it?" she asked. "Does Pele have a ring of meteoroids?"

"No, Maria would have identified one, even a thin strewing of gravel, and told us. Implausible anyway, on general principles. I have been speculating, though, whenever I got a chance. A notion has occurred to me. It may be utterly wrong."

An eagerness flickered amidst the forebodings. "What is it? I promise not to laugh."

"Thanks. I badly needed a grin." Raden spoke on as they made their way to the space gear lockers and busied themselves there. "Do you remember the anomalous iron content Maria found in the high Kumukahi atmosphere?" She nodded. "We don't yet know what spews it out. I'd say the best guess is convulsions in the planetary body; then rising air currents—what storms those must be!—bring it aloft. Pele isn't an ultraviolet emitter on the scale of Sol or Alpha A, but that close, Kumukahi surely gets plenty to split molecules or radicals into atoms—ionized atoms—once they're up where the air is thin. Then—here's my guess—tremendous magnetic fields are interacting, the star's and the planet's, changeably, chaotically. It may result in vortices that pull ferromagnetic atoms together over an enormous range. They join into macroscopic clumps, pellets, perhaps still carrying some charge. Then a surge in the fields accelerates them to escape velocity, or nearly. They're thrown out of the atmosphere, probably in bursts, like shotgun fire. The sundiver ran into a cluster. The planet had given her such a velocity of her own that the encounter riddled her.

"Whether I'm right or wrong, the notion suggests precautions for the future, doesn't it? We need data, data, data, observations, missions, year after year before we can hope to make a halfway decent computer model." His tone and eyes came ablaze. "Unique in our experience. What a wild fluke of luck! What a chance to *learn!*"

For a moment the enthusiasm caught her too. She had always been fascinated by science, but none of her men before now had been scientists. To see, to be a part, of truly doing it—If nothing else, life with Craig would never be dull.

The mood chilled and hardened in them both. They had work on hand.

Elementary prudence dictated wearing space gear. It needn't be cumbersome full armor, simply protection against possible hot spots, noxious gases, or the like. They stripped off their clothes—gazes flying up and down, and a pulse in the throat—and took skintights from the suit locker. Those were easy to pull on. The molecules flowed to make a dermis from neck to ankles, shinily reflective, leather-tough, silk-flexible, veined with electronics and tiny capillaries for exuding sweat vapor or other unwanted fluids but sealing the body off from the outside. Boots snuggled similarly to feet and ankles. A backrack went on nearly as readily, for powerpack, airtank, regulators, water supply. The collars of the clear, hard helmets made themselves fast to shoulders and coupled to the rack. The wearers could talk by radio or, with sound amplification, directly; they likewise had good hearing, while sensors woven into the integument provided tactility.

His smile quirked at her through the barriers between. "All set for the dance, Tyra?"

"Well, I'll take a promissory note for my corsage," she forced herself to reply in kind.

Sternly: "To repeat the doctrine one

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last time. I go first. You stay behind at the entrance till I call for you. If I call, 'Get away!' instead, or you realize that something's gone seriously wrong, close our airlock and release the gang tube. Worning will instruct you how to bring *Caroline* back. This isn't heroics, it's plain common sense, and you know how and why to follow orders."

Softly: "Not that I expect danger. Horror, perhaps. You may well be tougher than me, dealing with that. You're a remarkable lady, Tyra, and I'm an incredibly lucky man."

"I love you," she whispered, and knew she meant it. Whatever happened in the future, she had been set free of regrets from the past.

They waited for a span that felt endless, although clocks showed little change. Then she felt a thud go through metal and knew that the vessels had made contact.

She stood trying to visualize events. *Caroline* nudged the sundiver. Both recoiled the least bit. The autopilot had gauged nicely; airlocks were nearly aligned. *Caroline*'s gang tube need only extrude two or three meters to enclose the lock opposite and grip with molecular forces. The search program got busy as directed, stimulating crystals into vibrations that it detected and analyzed. It found the combination that would activate the mechanisms. Quantum levels fluctuated, utterances of command. Engines in the outer and inner portals of the kzin hull swung the valves aside. Gas billowed into the tube. Instruments verified that, while not in any normal state, it was not potentially destructive. *Caroline*'s lock opened.

Heat rushed over Tyra in a flood. Protected, she felt it only slightly. The suit could maintain her in the oven for several minutes at least. She was flashingly, selfishly glad she could not smell whatever stenches the inflow bore.

Raden sprang forward. She followed as far as the airlock chamber and halted. Raden spun upward. His heels kicked ridiculously as he went out of her sight. The gravity polarizers inside the sundiver had failed too, she understood. Well, he knew how to handle himself in microgravity.

After a few hundred heartbeats his voice reached her. "Come on through, Tyra. There's just one of them. He's in bad shape, but alive. Come help me bring him over to us."

15

Heroes scream when they leap to do battle. They bear pain in silence.

That was a battle of its own. Ghrul-Captain had never dreamed how long and lonely it could be. Often he wanted to make an end. If necessary, he could claw his throat across.

But his folk might yet regain the spacecraft. Finding his body, they would see how he died. If he had endured to the end, always watchful for the chance to somehow strike back, they would bring home his praise. His kin would gain pride, and renewed standing. He would live on in memory, song, fame. If what he had done turned out to be to the good of the Race, he might be given a shrine and yearly blood sacrifices.

If nothing else, they would remember how he had dared. Something no kzin had ever done before. Something no monkey ever would.

Yes, let him keep this before him, that he was not a monkey who whimpered and fled, but a Hero.

He bobbed about randomly. Now and then he bumped into a side of the cabin. Though the lining was a soft insulator, every touch seared, and he jerked free with the breath hissing between his fangs. His fur was singed, his whiskers scorched, his tail one blister from end to end. Each shallow breath filled his breast with pain. His ears were clenched tight. He seldom opened his eyes to the parching, baking air. Dreams had begun to weave distortedly through the darkness behind the lids. He tried to fight them off.

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If only death would come, the cool, kindly night—No, he must not think so, the wish was unworthy of a Hero. Let him rather hold that fact to his bosom, and the victory over the monkeys he had achieved.

It was what meant most, he thought whenever the tide of delirium ebbed back for a while. If only within his own spirit, he had struck a blow at them. Someday they would find out how deeply the blade had gone in. One stab, true, one out of the millions it would take to bring them down and avenge the Race, but his.

Something stirred, something made noise. He hauled himself to full awareness. A shape, not a vision, a real thing that touched him—anguish lanced; he almost cried out—and gabbled. Behind its helmet was a face like the face of a flayed corpse.

Monkey.

Another soared in. He snatched for recollections. *Strong Runner* swung afar. The monkeys, the rich, battening monkeys had sent boats out. One had laid alongside his.

What did they want? To take him captive, maybe try to sell him back to his folk—to seize the knowledge his vessel had won from the wreck of a world—or hand him over freely and gloat?

It hardly mattered. They were monkeys, victorious.

They were pulling and shoving him with them.

No, never. A kind of joy gleamed through the pain that had become Ghrul-Captain's universe.

Monkeys crawled around in their tree. They jeered at the hunter below and pelted him with dung. But all the while, their bough was bending under their weight, until they were in reach of him.

To kill these would be his vengeance for the Race and himself. What happened afterward mattered little. He might or might not be able to pilot their craft back to *Strong Runner* in time for the medic to save him. Certainly their fellow monkeys would shriek and jabber; but they'd do nothing decently warlike. Certainly, too, his achievement would go far toward inspiring the Race, would help hasten the day of reckoning.

His warrior skills returned to him. He should bide his time, let them carry him off to where he'd have weight under his feet, where he'd draw some lungfuls of air like the air of home. Then he'd be ready. Enough strength would flow back for long enough. Later he could rest in the blessed cool, rest and rest, sleep and sleep.

To loosen his muscles was the start of his preparing. He shut his eyes again and tried not to wince or gasp when the monkeys touched a burnt spot. They didn't mean to. There drifted through him a recollection of a teacher at his academy, discussing the monkeys, saying, "What they call conscience makes cowards of them all."

16

"Easy, now, easy," Raden said. "The poor devil. You or I wouldn't have survived this long, or wanted to. We can't let him crash on the deck when we enter our gravity field."

"No," Tyra agreed, "but we can't drag him to the first aid station either. He *weighs*," that huge body.

"Yes. I think probably we'd do best to turn off the polarizer while we convey him. First, though, for God's sake, we have got to get him out of this damned kiln."

They maneuvered the kzin through the gang tube. Straining, they eased his sudden ponderousness to the deck beyond. He lay sprawled, seemingly barely conscious. The eyelids weren't quite shut, a yellow slit gleamed between. Raden straightened and tapped instructions for airlock closure. Ventilators whirred, sucking away the hot air. Tyra imagined that, through her suit, she felt the freshness gusting in. She stepped a pace aside to catch her breath. Her glance flitted across scorch marks, blis-

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ters, raw fire-wounds. I suppose this was our duty, she thought. Do we have any analgesics that work on kzinti? Maybe they can tell me on our ship or maybe we can only make haste there.

The giant stirred. He struggled up. For half a minute he stood unsteadily, breath harsh in his throat. Bloodshot eyes glared.

"What the hell?" Raden exclaimed. "Don't be afraid. You're with friends now."

Silly, flashed through Tyra. The kzin probably doesn't know English. And if he did, would he listen?

He didn't quite scream and leap. He uttered a hoarse, broken cry and lurched toward the man. Claws slid forth. He swiped a mighty arm. The spacesuit fabric ripped.

"No! Don't! Are you crazy?" Raden stumbled backward. The kzin followed. Again he slashed. Raden barely dodged, into a corner.

And we have no weapon, Tyra silently shrieked.

Maybe I do! She wheeled about and fled. Growls, snarls, and human yells pursued.

Up the companionway. Down the passageway. A remote part of her knew how fast she bounded and ran, but it felt nightmarishly slow. Swivel through a doorway into the tiny galley. The largest knife she had brought gleamed in a rack. Her father had taught her to always keep cutting tools sharp. She snatched it and sped back.

She half expected to find Craig disemboweled. But he knew his martial arts, sidestepped, ducked, weaved, dropped to the deck and bounced up again. The kzin was slow and clumsy. Though red flowed from half a dozen shallow gashes, the dance of death went on.

The kzin didn't see her, or reckon her for anything if he did. She got behind him and sprang. Her legs clamped around his great barrel of a body, her free hand dug into an ear and hauled. The knife struck.

The kzin coughed a roar and reached back. She clung while she worked the blade across his throat. Blood spouted. She felt claws rake through her own suit. She clung and cut.

The kzin buckled. She let go and jumped clear. The kzin went to his knees, to all fours, onto his belly. He struggled for a while as the life pumped out of him.

Tyra had left the knife in his neck. She and Raden fell into each other's arms. "Are you all right?" she choked.

"N-nothing serious, I think. You?"

"Same."

They stood thus, shuddering, until the body slumped and lay quiet. Blood reddened the chamber; excrement befouled the deck. So much for a heroic death, thought Tyra vaguely.

"What shall we do?" Raden mumbled.

She rallied a little. "Take care of our injuries. Disengage the spacecraft. Call our own. And . . . and send this corpse out the airlock." Unwillingly, she thought: Let him go on to the stars. "Set the pilot for rendezvous with *Freuchen*, and go to sleep. Sleep and sleep. Later, we can clean up this place. And think."

They trembled for an hour or more. A kzin wouldn't have. But they were merely human.

17

The captains met with them in Bihari's cabin aboard *Samurai*. She wanted complete privacy.

"You were wise not to report more than the bare minimum on your way back," she said. After they arrived and gave her the whole story, the medical program ordered them to sickbay for two daycycles under sedation. Released, calmed, they would need a while more to feel entirely fit. However, a flit across to the lancer was, if anything, refreshing—a sight of stars, Milky Way, majesty and immensity.

Worning nodded. "*Ja*, we can't be quite sure the ratcats don't keep a few little receivers orbiting about; and you

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didn't have the equipment to encrypt."

Raden winced. "I, at least, didn't trust my judgment in this case either," he confessed. "How might the kzinti react to a . . . a terrible incident?"

"I could have told you that," Tyra said. "I'm damned glad we have a better warship than they do."

"They don't have the news to react to in any case," Bihari stated. "When they discovered that you'd made a short contact with the sundiver, they finally replied to my messages, demanding to know the details. I put them off until you came. Then I informed them that you found the pilot dead. Ghrul-Captain, he was. The master himself."

"Daft," snorted Worning. "You don't send a skipper off like that. They're maniacs, the whole lot of them."

"They're different from us," protested Raden.

"Which makes them deadly dangerous," Tyra retorted.

He sighed. "I've admitted to you, darling, I've been shocked out of, of what seemed like realism. Yes, we do need to keep on guard. Although negotiations—Well, I was afraid the blunt truth might antagonize them. So I left it to you professionals, Captain Bihari, to explain things tactfully."

Tyra shook her head and clicked her tongue. He was honest, he'd change an opinion when the facts convinced him it was wrong, but down underneath he'd always be an idealist. Which probably was part of his being lovable.

"What did you say to them?" she asked.

"That you'd made a gesture," Bihari answered. "Because his vessel wouldn't cool down before he was roasted like a food animal, you gave him space burial. A mark of respect and honor. Shayin-Mate, the present master, seemed pleased, perhaps a bit relieved. I added that you did nothing else aboard, never touched the databases, which they could verify as soon as a mission of theirs overhauled the derelict."

Raden's haggardness lighted up. "Excellent, ma'am! Tyra and I won't let the secret out either, will we, darling?"

"I'd like to," Tyra replied. "You were so brave and—"

"Scarcely like you." His hand reached for hers.

She shrugged. "Needs must. The story wouldn't give them a pretext for starting the next war. They aren't ready yet."

He frowned slightly but kept silence.

"Maybe it could complicate diplomacy a little, though," Tyra went on. "And surely it'd complicate relationships here at Pele. All right, ma'am and sir, it won't go beyond the four of us." I'll keep the glory to myself, and wish he'd share it with me, but he never will, she thought.

He relaxed and laughed. "I couldn't have robbed that database anyhow," he said. "Couldn't have endured the heat and wasn't acquainted with their systems."

"I wish you had been," growled Worning. "I'll hate seeing that knowledge fall into their claws."

"It cannot be critically important," Raden reassured him. "Once we've established a permanent scientific presence—robotic, no doubt, but permanent—we'll soon have all of it and much more. Meanwhile, we've gotten the truly invaluable piece of information. Not just that there's a hazard we must protect future probes against, but that there's an extraordinary phenomenon. Whether or not my hypothesis about the iron proves out, we hold a clue to understandings we never even knew we lacked." His voice dropped. "Tragic, that a sentient being died for it. If only we could commemorate him somehow—"

Jesu Kristi, thought Tyra, after he did his best to kill us? Then, ruefully: That's my Craig.

"But we *have* learned," Raden said, with a lilt in his voice that she also knew. "This alone justifies our expedition. Let the kzinti take what he earned for them."

"As a matter of fact," answered Bihari,

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"they aren't going to." Startled gazes sought her. "Shahin-Mate told me he would launch a missile—he told me exactly when, giving us plenty of time to track and stand alert—that will overhaul and destroy the sundiver. It started off about half an hour ago. He also said, umm, 'The Heroes have accomplished everything they intended, and will return home very shortly.' The latest indications are that preparations for departure are already in train."

"Kzinti—simply giving up?" asked Tyra.

"Well, perhaps they have no boat capable of rendezvous with one on such a trajectory. *Caroline* barely was, and the parameters were more favorable than they are by now. Under no circumstances would the kzinti make us a free gift of anything the mission gained. On the other hand—I can't prove this, it's an intuition, but rising from experience. I strongly suspect Ghrul-Captain was the driving force behind their entire venture. The acting master may well be seizing an opportunity to minimize his role, or actually make him out to have been a fool. Thereafter Shayin-Mate becomes the paragon who frustrated the humans, salvaged everything that could be salvaged, and brought his ship home to fight another day. He can hope to be made Shayin-Captain. Kzinti have their own internal politics."

Tyra grinned. "Not altogether unlike ours, hm? You're right about that much, Craig."

Her look upon him remained soft. He returned it. The humans wouldn't be here much longer either. She'd insist he take several weeks' leave of absence, or vacation or whatever they called it in Earthside academe, to spend with her. She wanted him to meet her father. She wanted to show him the merry old inns of München, the ancestral house and sea-cliffs at Korsness, the scenery and geysers of Gelbstein Park, the tremendous overlook from the peak of the Lucknerberg, the dancers in Anholt, all the wonders of Wunderland. Maybe later he could take her likewise around Earth. Maybe then they could think about making a home. ■

(EDITOR'S NOTE: This story uses the background of the Man-Kzin Wars series by permission of the creator, Larry Niven.)

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Stemming the Tide of Aging and Disease

Kyle Kirkland, Ph.D.

Stem cells may serve as an extremely versatile biological repair kit—if they're allowed to.

A salamander doesn't have to worry too much if it loses a foot—in a few months the foot usually grows back. Sometimes fish can regrow lost fins. And some species of worms and marine sponges can perform amazing amounts of regeneration, regrowing the entire animal from just a small part.

In comparison, humans aren't very well endowed in the regenerative arts. As far as we're concerned, nature seems to have invested most of its energy into making a big brain. True, the brain can rewire itself to a limited extent, so that it can learn something new or recover from a slight injury. Most of our parts, however, aren't easily replaceable.

But that may be about to change dramatically, thanks to stem cells. If we can figure out how they work, we can play the regeneration game too. And that's what this article is about: the possibility of using stem cells to replace lost or damaged tissues.

I'd like to start off with a definition of stem cells. I'd *like* to—but unfortunately, not only is our understanding of stem cells a bit fuzzy, scientists can't even agree on exactly what a stem cell actually is. So I can't give you a precise definition. But there are two properties that are generally required of cells to be considered for stemhood: self-renewal—meaning that when stem cells divide, at least some of the progeny are also stem cells—and pluripotency—the ability to produce a wide variety of cell types. If your knowledge of biology is hazy and you didn't quite understand the last sentence, don't worry: in the next section I give a brief review of the basics, so help is on the way.

But everyone has probably at least heard of stem cells, if only because they've been in the news so much lately. The event that really started people talking happened in 1998, when two research labs managed to isolate human embryonic stem (ES) cells (Thomson et al., 1998; Shamblott et al., 1998). Actually, some scientists prefer to call these cells ES-like, to emphasize the fact that some of the features typically associated with embryonic stem cells have not

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been demonstrated in these cells—and can't be, for ethical reasons. (More on that later, including the controversial derivation of human ES cells—or ES-like, if you prefer.)

But stem cells, especially of other species, have been studied for several decades and have already produced some fascinating results. Biologists commonly use mouse stem cells to make gene "knockout" mice; the mice lack a specific gene and scientists try to infer what the gene does based on the animal's properties (or lack thereof).

Obviously that's not something we might do with humans. (Some people think we shouldn't do it with mice either—and although I don't agree with this opinion, I respect it as a legitimate point of view.) But stem cells also have a rich clinical potential, including tissue replacement, tissue repair, and as a medium for gene therapy. It's been estimated that over 100 million Americans alone have a use for stem cell therapy (Perry, 2000), and although that number strikes me as a bit high, all of us ultimately could do with a good anti-aging prescription. I'll discuss the possibilities as we go along.

And what about the problems? There are always some, and in this case, the problems aren't just scientific—there are serious ethical concerns, too. Research on human embryonic stem cells typically requires—well, you can guess from the name what it requires, and that's a very delicate and controversial issue. There used to be a ban in the United States on federal funding for such research, but the National Institutes of Health—which holds the government's purse strings for biomedical research—lifted the ban in August 2000 (although there are still significant restrictions), receiving in the process quite a bit of criticism from certain groups, including some members of Congress (so it's unclear whether the ban will stay lifted).

Fortunately, there may be a way out of this dilemma. Evidence is beginning to accumulate that adult cells have much more potential than previously thought, and the use of *adult* stem cells—particularly if they're your own—should cause no protest. I'll have a lot to say about this later, too.

One cautionary note: this field of research is moving fast. Indeed, two important papers came out in *Science* just as I wrote this article. There's a danger that what I say here will be out-of-date with unreasonable swiftness. However, I've tried to avoid being too specific in areas that are likely to change soon, so hopefully obsolescence won't be so immediate.

A brief review of human development and biology

Readers with a good understanding of biology can skip this section; my goal here is just to provide the minimum necessary background.

It's truly remarkable that all of us, as complex as we are, started off as a single cell (a zygote). Most people know that the zygote forms from the union of a sperm cell and an egg cell called the oocyte, although many people spend more time thinking about the behavior which brings this about.

So how does one cell become a highly complicated organism with trillions of cells? Obviously there's a lot of growing and dividing going on. (In order to "reproduce" a cell splits in two.) But there's more to it than that; not only do we need a large number of cells, we also need a large number of cell *types*. Skin cells are different from brain cells, which are different from liver cells, which are different from heart cells. . . . Each cell type has a specific job to perform and has a different repertoire of properties with which to do it.

The particular type that a cell becomes depends on which genes it uses. While virtually all cells in an individual have basically the same set of genes, cells only use or "turn on" a subset of those genes, and different cell types

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turn on a slightly different (though somewhat overlapping) subset. Proteins are made only from this subset—we say that these genes are "expressed"—and the other genes are silent.

The zygote is sometimes called "totipotent"—clearly its progeny gives rise to *all* cell types. (But strictly speaking it isn't a stem cell—it doesn't self-renew.) During the process of development of an organism and throughout the numerous cell divisions, most cells quickly lose the potential to become any type of cell and instead become more and more like a specific "mature" type of cell. However, some cells remain "pluripotent"—able to make a variety of cell types—for a long time, sometimes throughout the life of the organism; pluripotent cells in the brain, for example, remain able to divide and produce different brain cell types such as astrocytes or oligodendrocytes or sometimes even neurons. (This is an example of what most people call adult stem cells.)

When a cell loses potential it is said to differentiate, and a cell which finally expresses just the right genes to become a skin cell or a neuron or whatever is said to undergo terminal differentiation. As the name implies, terminally differentiated cells generally stay that way: it's more or less a permanent job, until the cell dies.

Cell growth and division, by the way, are tightly controlled. It's a very complex process, and it has to be. There's a fine balance between the need for growth and the need for stability. That's probably the reason why humans have such a limited natural capacity for regeneration: it would be too easy for the growth process to slip its bounds. Unfortunately, even with all of the controls it happens all too often; the result is called cancer. The problem is that all it takes is one renegade cell, who keeps making a lot of little renegades who are just as nasty as the original and who make even more renegades. The big downer is that with trillions of cells, sooner or later one or two are going to misbehave, even if it's a low-probability event.

Another painful fact: scientists can't make cells from scratch. If a person loses a piece of brain due to injury or disease, we can't just whip up another batch of cells in a test tube as replacements. It's true that sometimes we can keep cells in a dish, and this is done to grow skin transplants for burn patients, for example. Unfortunately, this doesn't work for most other tissues; the cells don't like it and they may turn into something we can't use, and besides, most of them die off after a while. The ones that don't die off are called "immortal" and they usually have something seriously wrong with them. In fact, they're often cancerous. Except stem cells, which can also hang around for a long, long time—yet another reason to love them.

Embryonic Stem Cells

After the zygote has begun to divide but long before the animal is born, there's a stage where many cells exist in a highly pluripotent state. At this point in very early development, the organism sort of looks like a ball of cells, and pluripotent cells can be found on the inside (the "inner cell mass"). In fact, these cells—called embryonic stem (ES) cells—are nearly totipotent.

In the mouse, the cells are relatively easy to manage and can be maintained in a dish. They can even be genetically manipulated. However, for reasons that aren't all that clear right now, it's very difficult to do this with cells from other species.

The situation in the human is of course much less studied. But as I already mentioned, in 1998 two research groups isolated what they claimed were ES cells. Where did they get them? One research group used "surplus" embryos donated by women who were receiving infertility treatment, and the other group derived them from fetal gonadal tissue obtained from abortions. Both of these groups, by the way, funded their research from private sources—not gov-

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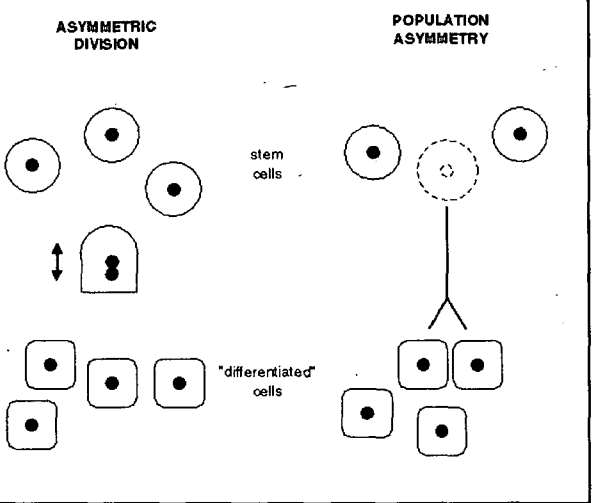
Figure 1



Stem cell division

ernment money.

These cells were shown to be pluripotent in basically the only way we know: to let the cells differentiate and see what types arise. In this case, nearly all types can be produced. However, one of the definitive ways of showing this—at least in mice—is to reinject suitably marked ES cells into an embryo, let it develop, and see if you can find the ES cell progeny in all the tissues of the organism. Not surprisingly, no one has reported this experiment using humans as subjects (and I assume it hasn't been done, though I suppose you never know).

In a moment I'll get to the ethics of all this. (I should tell you that while writing this article, I occasionally cringed.) But first I want to discuss one of the big problems—*scientific* problems—of using stem cells.

It can be stated simply. We don't know how to control the process of differentiation; specifically, we don't generally know how to get stem cells to differentiate into the cell types we want to make. Therefore, even if you've isolated stem cells and can grow them in a dish, it's hard to use them as replacements.

For example, let's pretend you're treating a patient who suffered a stroke, and you want to replace some of the neurons that were lost. You can't just inject ES cells into the person's head. Some of the ES cells will divide and become neurons, true enough, but other cells will become something else—ES cells can become almost anything. The patient might thank you for the neurons, but he certainly won't appreciate the piece of heart, the molar, the section of intestine, and the two testicles that also grew in his head. (Which would give new meaning to the phrase "thinking with your gonads." Or "visceral emotion." Or "food for thought.")

You could try to gently nudge the stem cells along the path to differentiation—if you knew how to do it. In some cases, researchers have had some success with this (Schuldiner et al., 2000). But still you need some way of purifying

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the result: you need to make sure that almost *all* of what you're injecting into the patient's body is what you think it is (or is going to be). Not just a few cells, or half of them.

What makes stem cells able to differentiate into so many cell types, and reproduce themselves too? I know of two ways, and I've drawn a little diagram to illustrate them (Figure 1). One way is asymmetric division: the stem cell divides, but only one daughter is a stem cell. The other (unfortunate) one goes its merry way down the differentiation path. Asymmetric division can arise from an unequal distribution of intracellular molecules—one daughter cell gets more and the other gets less, due to the different concentrations in the two halves as the cell divides. The other way is what I'll call population asymmetry: a certain percentage of the stem cell population differentiates and begins to produce differentiated progeny. (Of course, some of the stem cells divide and produce two more stem cells, maintaining their numbers.) Perhaps the cells which differentiate received a signal that the other stem cells didn't get, possibly arising from spatially variable concentrations of extracellular molecules. Or perhaps it was some other sort of interaction with the environment.

However it happens, we've got to understand the mechanism better in order to use stem cells. We have to know which genes are turned on (or off) to make which cell types, and then we need to learn how to control the process.

It'd be really nice to have some stem cell markers, too—something that would tell you that you've got hold of a stem cell and not a look-alike pretender. Antibodies are in fact available for a lot of cell types—the antibodies stick to a protein that only a specific cell type makes, thus allowing you to make a positive identification. (Sometimes you can't tell just by looking.) But to my knowledge, there are few, if any, such markers for stem cells.

Let's finish up this section by discussing ethics. I know that some people have very strong opinions against research in which a human embryo is destroyed, but it really seems to be a question of exactly where you think life begins: at conception (in which case this sort of research is clearly immoral) or birth (in which case it isn't) or somewhere in between. As for my opinion, I sort of lean toward "somewhere in between"; say, at the time the nervous system is sufficiently developed to possibly-maybe-sort of support consciousness. (Being a neuroscientist, I *would* think something like that.) But I'm not foolish enough to think that this definition is any more convincing—or any less arbitrary—than the others.

One of the justifications of ES cell research is to find treatments for disease. One commonly cited example is Parkinson's Disease (PD), a particularly ugly disorder in which, for unknown reasons, a specific clump of neurons in the brain dies. You may know that doctors have occasionally alleviated the symptoms of PD by transplanting fetal cells into the patient's brain (although a recent clinical trial to assess the effectiveness of this technique was a little bit disappointing). The problem is that not enough fetal tissue is available to help everybody (or even more than just a few people); the cells have to be a specific type, and it takes six fetuses (cringe) to get enough material for one transplant (Barinaga, 2000).

If we can learn enough about stem cells so that we can grow them in a dish and control what type of cell they become, we'd have an inexhaustible source for such transplants. For a lot of people that's game, set, and match in favor of stem cell research.

Therapeutic cloning

Let's say you'd like to use embryonic stem cells, but you don't want to rob the cradle (so to speak). Anything you can do?

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Well, perhaps. But there are serious complications here too, alas.

You've undoubtedly heard of Dolly, the sheep which a few years ago was cloned from an adult animal. It was big news since it was the first time a mammal had been cloned by using an adult cell. Since then cattle, mice, goats, and pigs have also been cloned. The procedure is called nuclear transfer: the nucleus of an oocyte is removed and replaced with the nucleus of a cell from the adult animal. (The nucleus contains most of the cell's genetic material.) The oocyte is given a little jolt of current and sometimes—albeit very rarely—a viable animal emerges after implantation and subsequent development.

That's "reproductive" cloning. A procedure called "therapeutic" cloning has also been much discussed lately (though it's not been done yet in humans, of course). Basically it's the same, except the desired result isn't a living, breathing animal—rather, it's the stage of development in which there's that little ball containing so many ES cells. There would be your rich source of pluripotent cells.

What's neat about this is that the cells would be genetically identical to yours (barring a few mutations here and there, which probably wouldn't be a problem), because the nucleus placed in the oocyte would be from one of your own cells. If you want to make some replacement tissue, nothing would be better than having your own cells to do the job. Foreign tissue is usually attacked and destroyed by the immune system; organ transplants—which are actually quite successful these days—try to match the donor and recipient as much as possible, but still often require the use of somewhat risky immunosuppressive drugs.

But you're growing your own cells here, so you don't have to worry about graft rejection. Need a few extra brain cells as the years go by? Want some new skin? Another ticker? It would be almost like having access to a factory, ready to replace whatever tissue and organs become injured or diseased or just plain wear out over time.

Well, not quite a factory, unfortunately. With therapeutic cloning it would be easy, in principle, to make ES cells, and when we know a little more about the differentiation process, it shouldn't be difficult to make whatever cell types are needed. But making a whole organ, such as a heart, is something else altogether.

The problem is that an organ has a three-dimensional structure. Simply putting a bunch of ES cells in a dish and coaxing them to turn into the right type of cell isn't enough. You can use these differentiated cells to replace damaged cells in the body, but you can't replace an organ—it just won't develop on a plate. Developing organs in the embryo interact with their environment and with other organs, and it will be challenging to reproduce this in the lab.

While we're talking about the downside, let's mention another problem: where are we going to get the required oocytes? We can't just go to the market. Now, if we could find a nice enough donor . . . I've also heard talk of using an alternate source: oocytes from other species. (Cringe.) But that's unlikely to work, since not all of the genetic material of the cell is in the nucleus—a little bit of it is in the mitochondria (which play a very important role in cell metabolism). If you combined a human nucleus with, say, a cow oocyte, what you'd have is a hybrid—or "cybrid" as some people say.

So is therapeutic cloning a reasonable thing to do? It would certainly produce ES cells, but in some ways there seems to be just as much to object to as with the "old-fashioned" way of getting them. The ball of cells which are harvested could in theory fully develop if given a chance—and into another you, in fact. (Or at least a person who resembles you in a lot of ways.) And it won't fulfill the need for whole organs, no matter how many ES cells it can produce. Not unless the embryos are allowed to proceed

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much further along in their development. (Cringe. Cringe. *Cringe.*)

Adult stem cells

In the previous sections we've discussed the pluripotent cells of very early stages of development. But are pluripotent cells strictly limited to embryos?

Not too many years ago, it seems that biologists thought of young animals and old animals as having very little in common. Youth implied potential, and had properties that were dynamic; age implied the absence of any propensity to change and grow. But recently that view has been challenged; in particular, in my own field, neuroscientists are gradually realizing that the adult brain is far more dynamic than originally believed.

The same is true in other areas of biology, including stem cells. If you define a stem cell as something which self-renews and can differentiate into other cell types, then adult humans most assuredly have them.

We have to. We need them. Some tissues of the mammalian body turn over quite rapidly—meaning that periodically cells die and need to be replaced. It happens in the skin, the intestine, and the hematopoietic (blood-related) system, to name a few. The skin, for example, is exposed to the environment and its damaging influence, and especially to ultraviolet rays; consequently, human epidermis turns over about every two weeks or so. Another example: millions of red blood cells need to be replaced every day.

Where do the replacements come from? Stem cells.

Typically, adult stem cells exist in sort of a quiet state—just hanging around, not doing much. Only occasionally do they divide; but when they do, some of their progeny start to differentiate and enter a state of rapid proliferation. Thus a bunch of new mature cells are created.

As I already mentioned, stem cells exist in the adult brain, too. It used to be thought that stem cells were only to resupply the "glial" cells of the brain—cells which, unlike neurons, don't seem to be directly involved in computation, but do have an important role in biochemical processes. But now it appears that stem cells aren't just for making glia; sometimes *neurons* get made in the adult brain, even in primates (Gould et al., 1999).

It's surprising how many interesting things adult stem cells can do. Scientists have begun to wonder what else these cells are capable of doing.

Not that the biomedical community has ever really ignored adult stem cells. Bone marrow transplants have been going on for years and stem cells are one of the reasons why. In fact, purified hematopoietic stem cells can replenish the hematopoietic system of patients who've gotten bone-marrow-depleting doses of radiation and chemotherapy (Weissman, 2000). And it's not as if stem cells are exquisitely rare in adults. Some researchers are even hypothesizing that all tissues in the body contain a reservoir of stem cells.

But the big question is this: how many cell types can adult stem cells make? In other words, how plural is their potency?

Embryonic stem cells are highly sought after because they're nearly totipotent and presumably malleable. In contrast, conventional wisdom assumes that adult stem cells are at least partially differentiated; they've gone a little way down the path to maturity, and perhaps as they approach the cellular equivalent of middle age, they're a lot less flexible than ES cells (and maybe a bit more cantankerous as well). Adult stem cells might be able to make only a limited variety of cell types, and they may be much more persnickety about how they go about it.

Maybe. But recent experiments suggest otherwise.

The papers in *Science* which I previously alluded to are relevant here (Brazelton et al., 2000; Mezey et al., 2000). The press release for the papers was certainly catchy: "Turning blood

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into brain." The gist of the experiments is that those marvelous hematopoietic stem cells we discussed earlier can not only make blood cells, but also neurons—and they can do it *in vivo* (in a living animal—in this case, a mouse). The discovery was made after bone marrow transplants were done in mice; some of the transplanted cells ended up in the brain and appear to be very neuron-like. Surprise, surprise.

No one knows if this could happen in humans as well. But it certainly might, and from a careful study of some human patients who've undergone bone marrow transplants, researchers recently found evidence that these transplanted cells not only revived the hematopoietic system, but also became liver cells as well (Alison et al., 2000).

So the potential of adult stem cells may not be so limited after all. In some cases, it appears that even somewhat differentiated cells can be "reprogrammed" into producing a number of different cell types.

Unfortunately, right now scientists don't know exactly how cells are reprogrammed. Perhaps it has something to do with the site at which the transplanted cells find themselves. Cells aren't solitary—they strongly interact with one another—so perhaps cells in the environment send powerful signals to which the transplanted cells are listening. The signals are saying, "OK, buddy, 'round here we don't cotton to nobody but hepatocytes, so you better become one real fast." Or something like that. (But if enough cells are transplanted, they can form their own environment, and they won't listen to the "natives.")

No matter what the mechanism, ultimately reprogramming means a change in gene expression patterns. If we could understand these changes, we could understand what happens when a cell is reprogrammed. Gene chip technology—which analyzes gene expression on a very large scale—will be of use here.

If we could learn how to reprogram adult stem cells—assuming for the moment that human cells are actually reprogrammable—there's a lot of really cool stuff we could do. We'd be walking around with all the stem cells we would ever be likely to need. Periodic rejuvenation would be possible. All you'd need to do is extract the stem cells (from whatever conveniently accessible tissue produces the best cells), grow them in a dish (so that you'd have a lot of them), and then expose them to whatever molecules or "growth factors" are required to differentiate them into the proper cell type.

As in therapeutic cloning, there'd be no problems with immunological rejection, but unlike cloning, there would be no middleman (or middle-embryo) and thus no guilty conscience. Of course, it still wouldn't solve the organ problem. But it might go a long way toward solving other problems.

For instance, it could easily provide an opportunity to practice gene therapy on a reasonable scale, something that's tough to do otherwise. One of the difficulties with gene therapy is getting access to the particular cells you need to treat; but with adult stem cell technology, presumably you could do the treatment while the cells are in the dish. Even if the treatment isn't all that efficient, you'd have plenty of cells to work with, and all you would have to do is select the correctly treated cells and insert them into the appropriate tissue.

But his process doesn't have to be limited to repairing or replacing faulty genes. You could insert whatever kind of gene you want. Maybe you'd like to put in a gene that makes a therapeutic protein, or an enzyme that catalyzes some biochemical reaction you've always wanted but never had. Maybe you'd want the enzyme that synthesizes vitamin C, so that you wouldn't have to drink so much orange juice or take supplements. (Most other mammals have it, so why shouldn't we?)

It's all a big *if* right now, though. In fact, it's such a big if that scientists aren't

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ready to give up working on embryonic stem cells, despite all the promise of the adult variety. The general consensus in the scientific community seems to be that research is needed in both fields, at least until we know enough to evaluate one technique versus another.

But that means a continuation of research paradigms that some people find highly objectionable. Despite my occasionally irreverent tone, I do believe that serious discussion should take place whenever ethical questions are raised about biological research. As far as embryonic stem cells and cloning and all the rest of those goodies are concerned, we're at the point where we—meaning all of us, not just scientists—need to sit down and decide how far we want to go and how fast we want to get there.

I was going to end the article there, but then I read something that changed my mind. It was something that reminded me why I love science so much—profound truth is so often revealed.

What I read was this: vegetables have amazing regenerative properties, and a *single* cell from a carrot plant, for example, can sometimes reproduce the *whole* thing. That's the ultimate in regeneration. It also proved the truth of what I've always been told by some dear friends of mine, who happen to be farmers. If people were more like carrots, we'd all be better off. ■

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The Company Man

Daniel Hatch

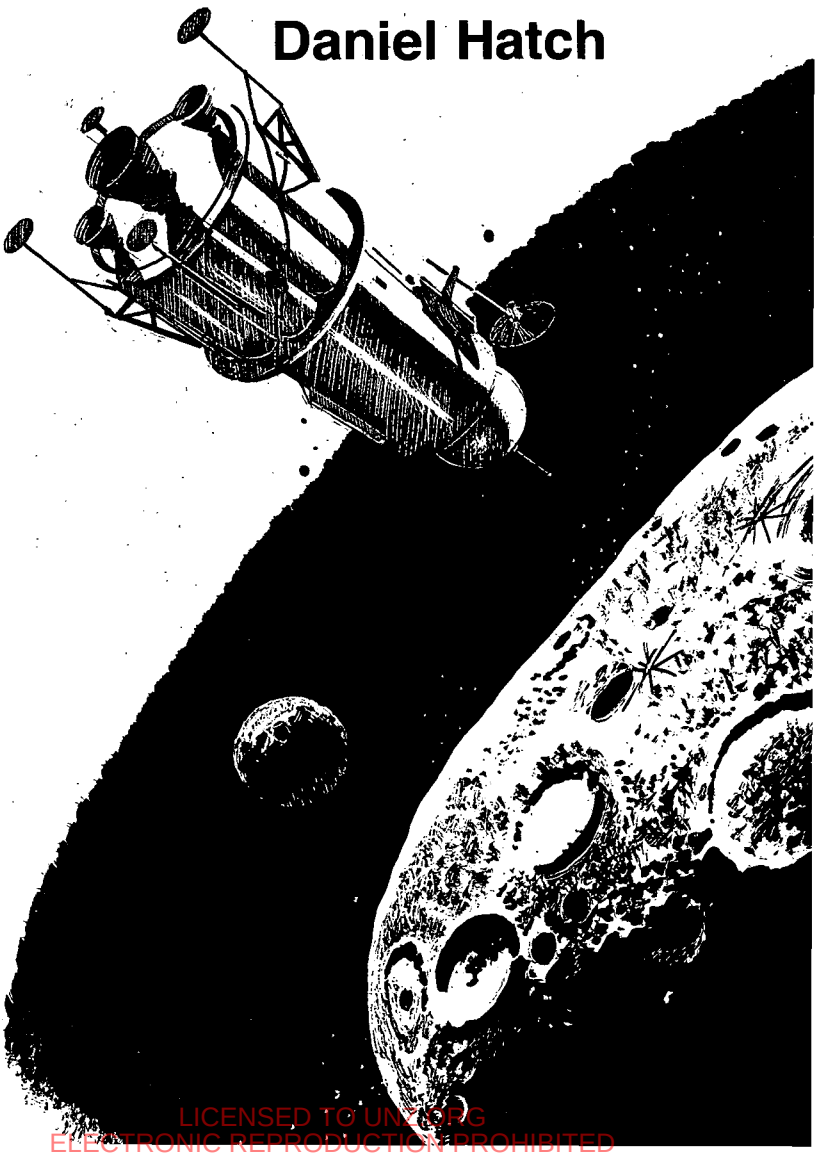

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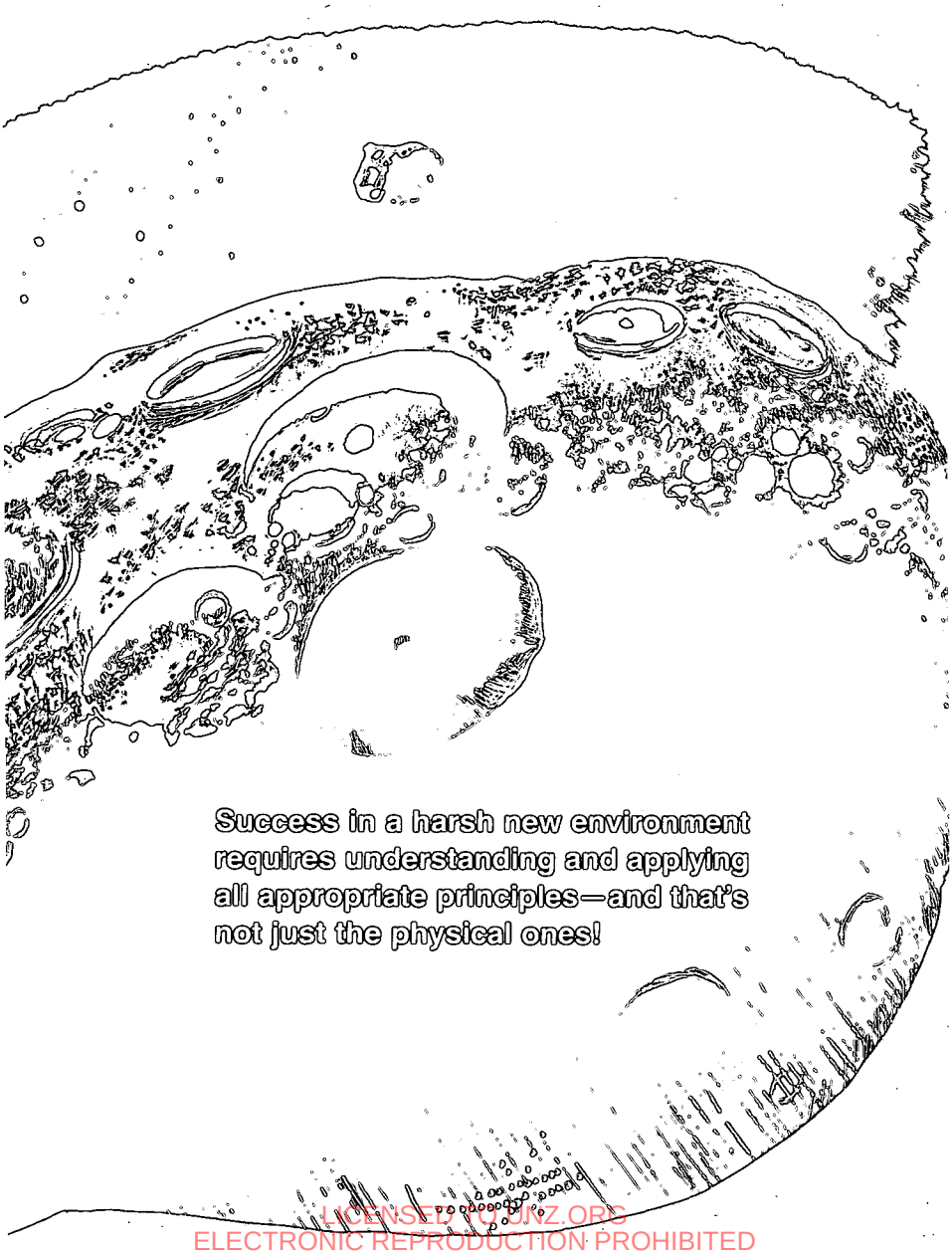
Illustration by Vincent Difate


Success in a harsh new environment requires understanding and applying all appropriate principles—and that's not just the physical ones!

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Gary Waters was in the hamster run, halfway up Big Rock Candy Mountain and just into the sunlight, when the alarm went off.

The rest of us were in the station down below and we heard it plain as could be, but up there on the mountain it was a different story.

The run was one of those serendipitous benefits of orbital mechanics and the economics of space. The spacejacks who rigged the mining station were stuck on 55664 Tiant for a month waiting for transport, so they spent the time putting the run together to keep busy.

They had the mining crew run three days of tests on the Mr. Plastics extruder—cranking out three thousand meters of tubing. Then they pumped out a few hundred gallons of isopropylene to seal the joints and the riggers went crazy.

There was nothing like it in space, the riggers said. You pulled yourself along, one handhold after another, through the black carbon-plastic tube. You felt like you were swimming through imaginary, frictionless water. Each long tug boosted your speed. After only a few pulls, you stayed afloat.

You didn't have to go far before you worked up a good sweat, cooling yourself by your passage through the air, with your heart pounding and your muscles burning up oxygen.

Every few meters, a ring of clear methyl methacrylate punctuated the black tunnel, letting in a flood of honey-gold sunlight. By the time you reached the clear top, the rings were going by about twice a second—nearly thirty klicks an hour in Tiant's millimeter-per-second minigravity and well beyond escape velocity for the little piece of rock.

I was too old and my bones were too brittle for such activities, but Gary was giving himself a hard workout, trying to crank up the endorphins and push away the stress of his job. He was the boss of the mining station here on Tiant, responsible for all of us—the fifteen mineworkers and support crew—and for producing a ton of volatiles a day, every day, for as long as we were here.

It was hard to say why he got the job. He'd never done much of anything outstanding. Maybe he was just lucky. When you make money in space, you make a lot of it. But chance, whimsy, and happenstance have so much to do with that, especially with such a small number of enterprises, that people get rewarded out of all proportion to the decisions they make. Sometimes just being there is enough to win you a reputation. Sometimes just being there is enough to ruin one, too.

Gary had been in on the first big commercial success in space. He was a crew chief on Phobos when Extraglobal built the first mines in there. Extra-G was the only contractor in on the project, so they didn't have to worry about competition, so that made success a little easier. And the International Investment Fund was paying a big chunk of the startup costs, so they didn't have pressure from the investors to make deadlines. All they had to do was avoid screwing up in any big way.

But the station on Tiant was different. Extra-G was trying to make the changeover from subsidy to self-sufficiency—a vast uncharted territory for the company—and now it was up to Gary to make the change work.

So when he wanted to forget his problems, his responsibilities, his doubts and fears, running the run was the safest way to do it. No moodies for him, just a hard aerobic workout with no one around to bother him.

The run twisted back and forth outside the habitats, then set off across the floor of Bull's Eye crater. That gave it a straight runout of three hundred meters. Then it followed the natural bowl of the crater and climbed up the face of Big Rock Candy Mountain. By the time it reached the cleft in the top of the rock face, the tube was perfectly perpendicular. Then it did a right angle turn and burrowed through the cleft until it came

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out the other side. From there, it wound its way down the compression ridge in a series of zigs and zags, winding its way back to the habitat.

The very top of the Big Rock Candy ascent was hospitably stuffed with plastic foam sufficient to safely absorb the kinetic energy of anyone who overshot the sudden turn. The tubes themselves were a little wider, just enough to allow you to tuck and roll. That let you get your feet above you to take the full force of the impact at the top of the climb, and it let you look back down the long, gentle arc of the tube.

If you weren't careful at that point, vertigo would threaten to overcome you. You danced on its edge, watching the rings of light go by, flash, flash, flash, until you hit. Then the jolt of impact would run through your heels, up the ankles, and through the knees despite the safety padding, but with no pain. Then you had to move quick to grab a handhold to keep from slipping back down the tube, and swing into the cleft tunnel.

That was where Gary told me he heard the peeping of the alarm back in the habitat. It was the tunnel's trick echo. Everyone knew about it. You could even hear the conversations down in the commons where the hamster run had its beginning and end.

The alarm was hard to identify. It could have been one of two things, both with the same high-pitched chirp: either the galley smoke alarm, usually set off by do-it-yourself cooks overriding the safety defaults, or the main environmental control failure alarm. There was no way to tell which one it was from up at the top of the run.

In fact, there was only one way to find out for sure—get down to the station and look.

The only problem was that the hamster run was supposed to be a one-way trip. The face of Big Rock Candy Mountain was meant to be climbed, not descended.

But Gary didn't have time to care about that. It would take too long to continue on and return to the station the back way. He swung around, yanked himself over the edge, then began the long pull back to the bottom.

What Gary didn't know, couldn't know, was that he was about to fall into one of those great moral dilemmas that shape your life for ever after.

He ran into Billy Chan two-thirds of the way down.

Neither of them was traveling terribly fast, but you can easily imagine the result: A collision that was all elbows and knees and panicked shouts and that knocked the wind out of both of them.

"Sorry, boss, but Miss Popalarkis said to go find you," Billy said. "We've got problems with the—"

"With the life-support system," Gary said. "I know. I heard the alarm. What kind of problems?"

"The thing is just getting hotter and hotter and we can't shut it down."

Gary followed Billy through the run and into the station proper. They found Anika Popalarkis with her head in the access port, stripped down to her shorts and a T-shirt, and me—Professor Sanchez, the mining operation's science guy and senior curmudgeon.

"What'd you do to it?" Gary asked. He was only half serious. Things like the life-support system weren't supposed to break down like this. If they did, it meant someone had done something to make them break down.

"I didn't do anything," Anika protested, her voice echoing around the inside of the housing a few times before escaping. "I don't know enough about it to break it."

"What's it doing?"

"Something is cooking up one of the chemical strippers," Anika said. She pulled her head out and stared wild-eyed at Gary. Her face was all red and sopping wet with sweat.

"Can you stop it?"

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"Maybe. Probably. I don't know. I could shut the whole thing down for a few hours. That might stop it."

"I don't think that will be enough," I said.

Gary, Anika, and Billy all looked at me at once. "Why not?" Gary asked.

"I was looking at the diagnostics," I said. "That reaction will sustain itself for a while whether we shut down or not."

"How long?"

"Your guess is as good as mine, but mine is two or three days."

"Two or three days?" Anika moaned. "We can't shut down for that long. The backup system is only good for twenty-four hours. And is this a bad time to ask why we don't have a backup system big enough to take over for the primary for more than one day?"

Gary winced. "Because if we did, then the habitat costs would make the station unprofitable from the start," he said.

"As opposed to being unprofitable after management gets through with it?" I asked.

He didn't even try to answer that one. Instead, he got back on point. "OK, next question: How hot is it going to get?"

"Too hot," I said. "More than uncomfortable. Unbearable. Hot enough to cook us all."

"What if we find some way to cool it down?" Gary asked.

Anika shrugged. "Don't ask me—I'm just a plumber, not a chemist."

"Makes sense to me," I said.

Gary nodded, then switched on his phone. "Mr. Firebow to the life-support bay, on the double."

I winced, but I didn't let Gary see me. Peter Firebow was the chief miner. He was a reliable technician, but he had what some might call a highly-focused mind. Others might call it a one-track mind. He had trouble paying attention to things that weren't immediately in front of him. Beyond that, he was a joy to work with, and we all considered his presence a pleasure and a benefit to the crew.

Firebow arrived a few minutes later.

"We've got another ten tons of raw ore coming through the tubes," he said. "And we'll get five more before the end of the cycle. Right on target."

"That's good news, Pete, but that's not the problem," Gary said. He explained the situation. "Now what I need is some way to cool this thing down before it cooks the whole station. It seems to me that a crew trained to dig ice out of the ground on a station equipped to do that ought to be able to figure out some way to solve our problem. What do you think?"

"You want that done before we get the five tons into the tube?"

"Before, Peter," Gary said. "This is what the manuals call an 'emergency'. That means you stop whatever you're doing and you do something else."

Firebow looked around the compartment, glanced upwards absentmindedly, then said: "I got you. I'll need about eighty or ninety meters of PVC piping, a pump, a 220-volt power line, one of my little screw bits, a spacesuit, and two or three hours. It won't exactly be ice we pump up, but it'll be cold."

"That's what I want to hear," Gary said. "Get going. And in the meantime turn off the fans. Maybe we can find some way to keep cool while you're working."

It was a little more than three hours, but when Firebow was done, we had a pipe running through the life support compartment that carried a slurry of subsurface regolith. Anika Popalarkis had rigged a jacket of plastic around the assembly—burning herself only twice in the process—to capture the slurry, and Gary finally allowed himself to relax.

If he'd been back on Earth, he would have sagged into a plush leather desk chair. But here on 55664 Tiant, the best he could manage was to swing into his office, position himself over the plastic seat behind his work station, and strap

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himself down.

By the time he was buckled in, I was in the doorway.

"Things are under control, Gary," I said. "You can exhale now."

"I just thought it might help if I held my breath until we got things running again," Gary said. "Come on in and have a seat. You know, Professor, it's days like this that make me afraid to get out of my sleeping bag."

"I thought you handled it extremely well," I said with a smile. "Excellent decision-making, excellent delegation."

"Me? I'm afraid you must have missed the blind panic I was working so hard to cover up. If you ask me, they screwed up when the assigned me to this billet. The company must have figured I was one of those guys with ice-water in their veins and nerves of steel."

"And you're not?"

"I'm just another ordinary guy like everyone else around here," Gary said. "I just look like a company stiff. It's the jaw. My parents picked it out at gene selection. Just because it's big and square, people think you come with the whole package. That's the problem with gene selection. My folks thought I was going to be a football star, but I ended up learning to play the piano instead. You should hear me sometime. I can really belt out the blues."

"Does that mean I shouldn't tell you how it happened?"

Gary winced. "Do I really want to know?"

"It's not our fault, if that's what you mean. Anika got a tech-support message reminding us that it was time to conduct some regular maintenance on one of the life-support subsystems. The message came with instructions on how to clean out the canisters that are overheating."

"And the instructions were wrong?" Gary asked, making an educated guess.

"We were victims of our own responsibility. We were one of the first units to do the maintenance and get in trouble."

"Management by Mr. Ferkuson. You know, the guy in the comics?"

"I know him, but you're not quite right. Ferkuson is the engineer. The manager is the bald guy with the eyeglasses. Sort of like Frankenstein being the name of the mad scientist and not his monster."

"Whatever. It's the bane of my existence. They spend a billion megabucks to set this station up. That means we have to turn out a ton of shippable cryogenics every twenty-four hours. And this latest fiasco puts us another ton behind—seventeen tons total since we started up."

"Details, details, details."

"I suppose, in the vast scheme of things, they're just details. But my job and my career hang on details like that. And it seems that harder I work, the harder it gets."

Then the communications link chimed, announcing the arrival of the message from corporate headquarters that would make it harder still.

They named our asteroid after a 20th-century baseball player. After the first ten thousand bits of rock, they started using any list of names they could find. It was discovered back sometime around the turn of the millennium by a team of Air Force techs who had access to a superfast charge-coupled device. Most CCDs took minutes to recharge, but this thing took milliseconds. It was built for some spy satellite that was taken off the Top Secret list after the end of the Cold War. With it, they could scan the whole sky in six hours—five times. A computer scanned each of the five images and selected out everything that didn't move and compared what was left to known objects. At the end of the first year, they'd doubled the number of named asteroids and left the asteroid scientists crying in their beer—people who had worked all their lives to get enough funding to begin their search of the skies just in time to see it all done faster, better, and on the Pentagon's bud-

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get.

Tiant was a mile-long chunk of rock mixed with chondrites, longer than it was wide, and wider than it was thick. It had been sandblasted with interplanetary debris for four billion years, leaving it with softly rounded edges all over and a continuous splattering of craters, large and small, that ranged from microscopic to the big Target Crater, which covered half of one face. The impact that created the crater also pushed up a slab of stony ledge to form the Big Rock Candy Mountain.

It was one of those Near Earth Orbit objects that made the faint of heart think about dinosaurs and extinction. Its orbit was close to Earth's with no inclination to speak of and just a little eccentricity. The lack of inclination made it attractive to space miners like Extraglobal Resources Corp.—getting there and back was cheaper and less complicated because of it.

The mining station had been there only six months, including the construction. For the first three months, Gary and I and our fourteen fellow crewmembers had lived in close quarters aboard the space riggers' ship. The tunnels of our new subsurface habitat seemed vast and airy in comparison to their little can. The ship offered us less than twenty cubic meters per person, while the new station allowed an extravagant hundred or more. The biggest cost was in volatiles to fill the void with breathable air, but a volatiles mine could afford to spare what was needed—as long as it didn't get overheated.

But the atmosphere wasn't the only thing getting heated up.

"I don't believe those people," Gary said after tossing his lapboard across the office and watching it carom off the wall. The spin gave it an extra impulse that kicked it into a three-bank shot, almost taking a piece of my forehead out in the process. I ducked and asked him to explain.

"The managers back home want to know what went wrong," he said. "Doesn't it ever occur to them that I have a station to manage? Just when I need to make up a seventeen-ton shortfall, they want me to stop what I'm doing and write a report on the life-support machinery."

"And you have a problem with this?" I asked.

"You bet I do. If I spend my time doing this, I can't spend it making sure that Firebow isn't cutting through rock instead of ice or that Anika isn't trying to fix the reactor the way she fixed the life-support system. Don't they care about the real work that has to be done out here?"

"Strictly speaking, they don't," I said. "You've got to remember that they live on the other side of the looking glass from us."

Gary rolled his eyes.

"I know, you want me to keep my lecture to myself. Too bad. What's the use in being the wise old man aboard a station like this if you can't indulge yourself with long-winded lectures to the youngsters?"

"Just how old are you, Professor?"

"Never mind just how old I am. This is my lecture, not yours."

"Is it true they put you out here just to baby-sit guys like me?"

"I'm here because the U.S. government pays cost plus ten percent for all scientific research. Any benefit the station derives after that is purely coincidental. Now are you going to listen or not?"

"Do I have a choice?"

"No. Now as I was saying, on their side of the glass, work doesn't exist. They spend all their time watching numbers on datascreens. Nothing is real but those numbers, nothing else matters. Unfortunately for us, those numbers are a poor reflection of our lives out here. Every buck we spend getting here, staying alive, doing our jobs, is a buck off their ledgers, a debit in their books. Every drop of blood, sweat, and tears

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we spend getting their product out of the ground is a buck of profit and a credit in their books. But the actual facts of work and life out here are beyond their imaginations. And that's why they're so nervous all the time. When things go wrong, there's nothing they can do about it, but everyone holds them responsible."

"I don't believe that, Professor," Gary said. "You've got to have faith that someone back there knows what we're doing out here."

"Yes? And what have they done with that poor soul? Wrapped him up with duct tape and coat hangers and hung him in a closet somewhere?"

"Sometimes it may seem like that," he said. "But if what you say is true, why even bother? Why bust your ass out here making money for someone else?"

"That's the big question that managers like you are supposed to answer," I said. "No one is out here just for the money. There are a lot safer ways to get rich—and more than half the spacers I know have never seen their money, they just keep rolling it over into space bonds. And they're not looking for adventure. Spending your time stuffed in a plastic can breathing recycled air is hardly the romantic vision of space conquest that you see online. In my experience, people are motivated by two things. They don't want to let their companions down—the reason soldiers fight in a war—and they don't want to let themselves down. Professionalism isn't quite the word that fits that, but you know what I mean."

"I know what you mean," Gary said. "This isn't just Extraglobal's mining station. It's mine too. And I want to do this job right because it's my job. But do you really think that's what's going through Pete Firebow's mind when he gets blue?"

"Are you asking me as his crewmate, or as the man in charge of dispensing moodies to the station employees?"

"Both."

"As a crewmate, I'd have to say that Peter is more motivated by the desire to do a good job than anyone else on this station," I said after a moment of thought.

Gary nodded.

"But he also needs a lot of anti-Ds to keep him from cracking up when he gets off work. I had to dial up Anika's dose too, or she'd ruin herself feeling guilty about today's mishap."

"That's too bad," Gary said. "It wasn't her fault."

"Emotions are not nearly as sensible as that," I reminded him.

"And what do I get for having to work extra hours writing reports that no one will read, explaining problems they don't understand with solutions that won't be implemented?"

"A central nervous system depressant might help," I said. "I have some rum that you might appreciate when you're done."

"You're not supposed to have that, you know," Gary said.

"It's all right," I told him. "It's on the master list of supplies for the medicine locker. And just remember one thing."

"What's that?"

"It takes six months to get a new manager to this place, so failure is not grounds for replacement. If you can't do the job right, they're not going to let you quit."

"I didn't really need to hear that," Gary said.

"I'll see you after supper," I said. "You bring the lime juice and we'll make Cuba Libres."

We got a good buzz on that night, and Gary finished his report the next day. Peter Firebow managed to avoid causing more problems, the life-support system cooled down to the proper operating temperature, and things returned to normal, more or less.

But Gary's problems were far from over.

One morning a few days later, I came

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out to the commons for breakfast and found it full of people. It was half an hour past shift-change, yet every member of the mining crew was there. You could tell something was wrong from the low grumble that vibrated through the crowded chamber.

I pumped some coffee into my cup and pulled myself across the room to Billy Chan. "Is there some holiday we're celebrating that I didn't hear about?" I asked him.

"Didn't you hear the news?" he asked back. "Extraglobal Resources filed for bankruptcy this morning."

I almost choked on my coffee. "They did? Let me see."

He handed me a datapad and I dialed up the newsfeed from the laserlink with Liberty Palace at L-5. Just as Billy said, Extra-G had filed for protection from its creditors under the Title 22 of the U.N. Bankruptcy Code.

"They didn't even have the decency to warn us in advance." Billy said.

I tapped on the datapad and linked to Gary in his office. "In case you haven't noticed, no one is working this morning," I said. "You'd better come out and talk to these guys, or they're going to stand around all day getting surly."

"Aaap," he said. "I'll be right there." He disappeared off the screen and an instant later came shooting out of the passageway. He grabbed a stanchion and swung around into the commons, then he caught his breath and moved more slowly in an effort to recover some pretense of self-control.

"Good morning, people," Gary said, projecting his voice above the grumble. "Is there a problem that I don't know about?"

"What about Extra-G?" Billy asked. "Have you seen the newsfeed?"

"That? I don't know why that would worry you," Gary said.

"The company's bankrupt," Billy said, his voice rising in pitch. "Of course I'm worried."

"Billy, the company isn't bankrupt," he said. "We just want to stop paying our bills for a while. It's all about cash flow. We're just trying to restructure our debt. It's just something companies do sometimes."

"We've heard that before," Billy Chan said.

"Well you're hearing it again," Gary replied. "You all know how these things work. This station is more than just a major investment. The power plant alone cost a half a billion megabucks. The mining equipment is another quarter of a billion. And our habitat is no bargain either. All told, we're talking a billion megabuck investment. The debt service on that is nearly two hundred million a year. As you know, we were supposed to be here on Tiant last year. But things got delayed in the pipeline, systems weren't available on time, and we're doing our best to get this place running smoothly as it is. It's going to be another three months before we ship our product and another three months after that before it arrives in low-Earth orbit. But some of our debts have started to come due. The IIF is dragging its heels and the investors are getting nervous. They want their bonds paid off on schedule."

"But what about our paychecks?" Billy asked.

"Your paychecks are all locked up in space bonds," Gary said. "The creditors can't touch them. The company can't touch them. They're as solid as Edison's Rock."

"I don't know, Gary," Billy said. "I've got a bad feeling about this. I don't like the idea of working for a bankrupt company."

Gary sighed and shook his head. "I told you, Extra-G isn't bankrupt. We're just taking cover during a financial solar storm. You don't want some Indonesian bank repossessing your sleeping bag while you work, do you?"

Billy pouted and shrugged. "No. But what if they can't reorganize? What if no one wants to loan them any more mon-

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ey?"

"Then we close the station down and go home a year early," someone said from the back of the commons. "And with two years' pay in the bank no matter how long we stay here. Isn't that right, boss?"

"Probably," Gary said. "I don't know what the exact legalities are, but if your salary is tied up in space bonds, it shouldn't matter what happens to Extraglobal. But I don't want people to start thinking that we're going to close the station down. We all still have jobs to do—and it's way past time to get to them. If anyone else has any questions, my door is always open. Let's get back to work."

Billy Chan wasn't happy, but there wasn't much left for him to say. The others grumbled some more, but they went off to work anyway.

I was more worried about Gary, though. All this could do was add to his woes.

A little while later, I found him in his office.

"You handled that pretty well this morning," I told him.

"Thanks," he said. "I'm glad someone thinks so."

"Just one question, though."

"What's that?"

"Why didn't you tell them the truth?"

"The truth? I thought I was trying to."

"I mean the truth about why Extraglobal is in trouble."

"Do you know something I don't know?"

"Nothing that wasn't in the newsfeed," I said. "Or didn't you bother reading past the first bit of bad news you found?"

Gary shrugged. "Maybe I did, maybe I didn't. Either way, I'm sure you're going to enlighten me."

"The real reason the company is sucking vacuum is that two days ago, Space Launch Systems Inc. announced that it was paying off the financing on its entire fleet of launchers early."

"I didn't notice that," Gary said. "Is it important?"

"Important? Don't you know anything about space economics?"

"Nope. Not me. I'm just a poor, dumb groundhog, digging holes in rock looking for ice. Don't know nothing about nothing."

"You know the market value of your volatiles, don't you?"

"Yes. That much I do know. Half a million megabucks a ton at LEO."

"And do you know why that's the market value?"

"Because that's what it costs to lift a ton of anything into LEO from the surface of the Earth."

"Then you're not as dumb as you pretend."

"I guess not. But what's that got to do with Space Launch Systems?"

"They paid off their financing. That's two-thirds of the cost of running a launch company. Now they can charge a third of what everyone else does. And you know what that means?"

Gary let his jaw grow slack, then started counting on his fingers.

"It means that we have to produce three times as much product to pay off the loans that Extraglobal took out to build this place," I said, trying to save him some mental effort.

"I had that much figured out," Gary replied. "I'm just trying to figure out how much farther behind that puts us. Up until today, with output at full blast, fifteen tons of ore a day, one ton of volatiles coming out the pointy end, we could make enough product in a year to pay our costs with a little bit left over to make everyone happy. Now, based on what you're saying, every day we work, we fall two tons behind."

I beamed. Gary was such a good student. "Exactly," I said. "And that is the stuff that bankruptcies are made of."

We struggled through the next few weeks without incident.

Peter Firebow came up with a way to

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expand the maw of the mining equipment to take a bigger bite of the regolith, which nearly doubled the production of raw ore. The cookers and distillers were unchanged, and that kept us from taking full advantage of the increase, but we still managed to put out a ton and a half of volatiles a day. We caught up with our quota and even got a bit ahead.

Space Launch Systems Inc. decided to do what any good business would do—instead of cutting its prices by two-thirds, it set them a few points below the previous market rate and pocketed the difference. That was enough to keep the entire space economy from undergoing a catastrophic collapse, even if it meant artificially inflated costs for goods delivered to LEO. Sometimes greed is good for more than the greedy.

Then the rice hit the fans.

By the end of March, morale was starting to flag again. It happens when it gets near time for a supply shipment. In the early days, meals were prepackaged and preplanned and almost predigested. High-volume space traffic and cheap launchers changed that, replacing them with bulk supplies for do-it-yourself cooks. But it's six months between shipments and at the end of the cycle, the larder gets low. You try to plan your stores, but things never work out the way you expect them to. You use too much flour and sugar early on and don't have enough at the end. The beer runs out. People start living on stale peanut butter and crackers—and the crackers taste like cardboard. You start to ration the coffee.

And you serve rice with every meal because there's too much of it left.

The first sign I noticed was the random tick-ticking from the air ducts in the commons. I grabbed Anika Popalarkis as she passed through the compartment a little while later.

"What's that sound?" I asked her. We drifted there for a moment, sinking towards the deck as we listened. Tick . . . tick-tick . . . tick.

Then Anika looked around, ran her fingers through her hair, and pulled out a tiny brown kernel a couple of millimeters long. "It's this," she said, holding it up for me to examine more closely. I still couldn't quite recognize it, though it did look familiar.

"What is it?"

"Rice," Anika said. "Let's ask Firebow."

We found him off-duty, working in the machine shop on some exotic piece of equipment. He admitted his knowledge. During lunch that day, one of the miners spun around, yelled, "I'm sick of rice," and tossed a bowl of it across the commons. In the microgravity it splashed far and wide, getting into everything, sticking with starchy glue wherever it came to rest.

Until it dried out and shook free from the station's own vibration. Then it was picked up into the air ducts, where it ticked against the fan blades.

"At least it wasn't rice pudding," Firebow said.

For three days everyone was picking dried kernels out of their hair.

The next day, we found a new problem. Anika showed it to me. A whirling line of brown, uncooked rice, had spilled down the corridor, pulled along by the gentle drafts of the ventilators, collecting in the corners of the deck in tiny but intricate drifts and shoals.

"Any idea where it came from?" I asked.

Anika shrugged, so I went looking for Gary. I had to wait until he came out of the back end of the hamster run, but it got me an answer.

"Billy said we're missing five twenty-kilo canisters of rice," he said. "I don't know why anyone would steal rice when we're all sick of the sight of it."

"Because we're all sick at the sight of it," I said.

Gary rolled his eyes. "You're right," he answered. "I think I want to go for another run through the run."

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"I'll go looking for the rice," I told him.

We never did identify the culprit. It was an impossible task. Whoever did it was not going to come back for his loot. We would never find him munching on stolen rice in the dead of the night-watch. Whoever it was, he had hidden the canisters all over the station. The seals broke on two of them and we had rice drifting through the ducts and vents and passageways. At least it hadn't been cooked, so it didn't stick to anything.

We spent three days vacuuming the stuff up, but it still found its way into the fans and filters and ducts. Gary spent the time pulling and tugging his way up Big Rock Candy Mountain and down the far side. Life just seemed to be getting worse for him, and I felt helpless to improve his lot.

So we counted down the days until the R/S DiMaggio was due to arrive, indulging in fantasies of lobster tails, stuffed pork chops, lasagna, marinated mushrooms, fresh-baked biscuits, ice cream sundaes with chocolate sauce and nuts, and all the coffee you could drink.

The DiMaggio rode nuclear-thermal rockets with high thrust and high specific impulse. That cut the trip out from Earth to about six weeks from the six months a low-energy Hohmann orbit gave you.

The extra cost is worth it when you're moving contract employees around. Cargo doesn't get paid by the day. We weren't getting any new crew from the DiMaggio, but they were going to tank up when they got here for a transfer to Phobos. The planetary alignments were favorable for the maneuver. They were packing our supplies along as a way to save Extraglobal a few megabucks in shipping costs. It was a lot cheaper than using a dedicated cargo boat, with its long flight time and long cost-amortization.

They made their final burn to match solar orbits with Tiant when they were behind us, with the bulk of the asteroid to shield the station against contamination from the exhaust. Then they used their vernier engines to put themselves into orbit around the rock itself.

Everyone who wasn't on duty was in the communications shack, waiting to hear from them when they came over the horizon.

Billy Chan keyed the mike on the voice-radio and said: "DiMaggio, DiMaggio, this is the Tiant mining station, over."

"DiMaggio here," a voice replied, crackling through the monitor over our heads. "Orbit looks nominal and we're securing from maneuver stations, over."

"How soon before you can start shuttling down supplies?" Billy asked. "I promised the crew down here canned peaches, whipped cream, and shortbread with dinner as soon as you transfer cargo, over."

There was a long silence, then the reply: "Tiant station, there's been a small change in our instructions. We won't be transferring cargo, over."

An angry shudder swept through everyone in the compartment. Billy Chan's face twisted into a mask of pain. "What? Repeat that, DiMaggio. I don't think I heard you right, over."

"I say again, we won't be transferring cargo," the voice on the DiMaggio said. "Orders from corporate. This is a C.O.D. shipment and we've been told not to deliver it until Extra-G makes their payment. Sorry, fellows, but there's nothing we can do about it."

The angry shudder was replaced with a fierce growl, expressions of disbelief, scatological characterizations of the crew of the DiMaggio, and even worse descriptions of our employers at Extraglobal Resources.

I looked towards the entrance to the shack just as Gary hove into view. He paused at the doorway and summed up the mood of the crew. Then he spun in place and headed back the way he came.

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I figured he was heading for another circuit of the run.

I was wrong.

This time, Gary wasn't running away from his problems. He wasn't trying to convince himself that the company knew what it was doing even if he didn't. He wasn't trying to find some way to avoid the harsh truth that had arrived with the DiMaggio.

This time, he was on the line to corporate headquarters asking them the kind of questions that he should have asked them a long time ago.

I floated into his office in the middle of his message. We were a good ten light-minutes away from Earth, so conversations tended to be a bit one-sided. It had the advantages of e-mail—no one could interrupt you—along with the immediacy of speech.

"—that's the situation here," Gary said. "So what I want to know is this: What in the name of blue ice do you want me to do here? Are you going to pay the damn bill so we can eat this month and next? Are we supposed to pump their tanks full of volatiles so they can fly off with our supplies? Do you want us to pack up and go home with them?

"I'd like a little guidance here. It's one thing to make the decisions about running this place day by day. I have no problem with that. But do you want me making decisions about things that you people refuse to deal with back home? Do you really want to suffer the consequences if I choose wrong? Or are you just going to write us all off and move on to new jobs in the morning? At least you have that luxury. I'll still be here in the morning, and the morning after that and the morning after that.

"This is Gary Waters at the Tiant mining station. I'll be waiting for your reply."

"And so will I," I said.

Gary turned abruptly and shuddered. "I wish you'd knock before you eavesdrop," he said.

"I didn't want to spoil your style," I said. "I thought you were a company man."

"I am. But loyalty is supposed to work both ways. And they haven't been giving me much support lately."

"What do you expect them to do?"

"I don't know. This is a royal mess. According to the messages I got yesterday, we are obligated to transfer sixty tons of hydrogen and oxygen to the DiMaggio at their first convenience. They've got a contract and they've already made the payment."

"I may be wrong, but isn't the DiMaggio an Extraglobal ship? That's what I thought I saw in the registry."

"Extra-G owns it, but they lease it to Solar Transport, which operates the shipping business. The shipping contract is with Solar, which is an independent company. Well, more or less independent. We paid the startup costs, but then we let it go off on its own. Compartmentalization. They were afraid that if it went under, it might drag down Extra-G."

"Superior planning on their part."

"At any rate, corporate is still hedging when it comes to paying Solar Transport for our supplies. I don't know if they can pry the cash loose—we're talking a good twenty million megabucks—or if they'd just rather not."

"Do you have some reason to doubt their sincerity?"

"I'm not getting replies to my e-mail from the people who should be sending me replies."

"That's sounds ominous."

"So I'm at my wit's end," Gary said. "I have to do something, or this whole situation is going to crash badly. The crew isn't going to put up with nonsense from corporate. We could end up with a mutiny—or worse."

"That's a distinct possibility."

"What I'd like to do is put a rock through one of the DiMaggio's windows and force her crew to abandon ship.

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Then we could rescue them, claim the cargo as salvage, and all be heros."

"I'm afraid admiralty law isn't with you on that one," I said. "You can't claim salvage if you had a hand in forcing the disaster on the vessel."

"It was just a thought."

"And not a bad one," I said. "Too bad there isn't some way to bring the DiMaggio down without throwing rocks at it."

"Too bad. Maybe corporate will come up with something before we're reduced to that."

We waited for a reply to Gary's message for a long time before he went digging through his cooler for the rest of the lime juice and I went back to sick bay to find the rum. By the time I got back, they'd sent their answer.

It wasn't hopeful.

"Wait? Is that all they said?"

Gary shrugged. "Oh, they used more words, but that was the thrust of it. No explanation of what they're doing, though I suppose they're busy down there. No one is returning my mail again."

"I'm sure they're busy," I said. "But busy doing what? Refinancing our debt or writing up resumes and doing job searches on the cablenet?"

"Both," Gary said with a sigh. "But who can blame them? If I were in their position, I'd be doing the same thing."

"It's hard to make the transfer out of this office," I said.

Gary was quiet a long time. He had a distant look in his eyes, like he'd caught sight of something on the horizon—only you couldn't see a horizon from his office because it didn't have any windows.

"Did you ever get curious about the guy this rock is named after?" I said, breaking the silence. "Tiant?"

"He played for Boston, didn't he?"

"Back about sixty or seventy years ago. He was Hispanic, which made him a very important man to begin with. And he was a pitcher. He played in the World Series."

"I thought Boston never won a Series until the 21st century?"

"I didn't say they won. This was back when the American League had the designated hitter rule and pitchers didn't have to come up to the bat. But the National League didn't. So in the Series, the pitchers had to take their turn just like everyone else. They usually struck out or flied out pretty fast. But Tiant didn't. He hit a home run. A grand slam. Scored four runs and won the game."

"Is there a point to this story?"

"I guess so. I think it's that you never know what you've got until you step up to the bat. And sometimes it's more than anyone expects."

"I'm terribly inspired," he said.

"It shows," I replied. "I guess I'm not doing much good around here. I'm going on down to the communications shack to see what's up."

"The shack? What's going on down there?"

"All the off-duty crew here and on the DiMaggio are sitting around yakking it up. We're all pretty starved for a conversation with strangers where you can get an immediate reply."

"Sounds interesting," Gary said. "But I'm afraid if I go down there, it'll just give them an excuse to start the mutiny a few hours early."

"Give yourself more credit than that," I said. "Believe it or not, they don't blame you for any of this."

"I don't know why not," Gary said. "I do."

A few hours later, Billie Chan woke me from a fitful nap.

"Professor Sanchez, we have a problem out here," he said.

The way he said it, in a soft, anything-but-urgent voice, set my adrenaline flowing. My imagination spewed forth all the different kinds of problems we might have—equipment failure, solar storm, fire, pressure leak, bankruptcy, mutiny, and worse. I followed Billie out

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into the passageway and down to the communications shack.

"It's the DiMaggio," Billie said when we got there. "She's declaring an emergency."

My heart dropped from my throat back into my chest where it belonged. We didn't have a problem. Someone else did.

"Go get Gary," I said.

"Someone's looking for him," Billie said. "He was here a couple hours ago—talking to the DiMaggio for a long time."

"He was? About what?"

"Just talk. You know. Where are you from? Got any kids? That kind of thing."

"He wasn't in his office?"

"No. They're looking in the hamster run, but he doesn't seem to be there either."

"What about the DiMaggio?"

"They dropped below the horizon right after they declared. So we didn't get much in the way of details," Billie said. "We won't have them back for another ten minutes or so."

They were an awfully long ten minutes.

I kept thinking I heard Gary coming down the passageway, but it was always something else. Billie had a headset on and was scanning the frequencies, listening in on messages sent across the long light-minutes of the solar system from one tiny little can of air to another. It was the middle of the nightwatch, the lights in the station were dimmed, and no one else was around. It was one of those moments where you can hear the universe cracking in the deep silence, coming apart slowly at the seams, one seam at a time.

Gary arrived just as the DiMaggio came over the horizon, a strange, guilty smile hanging on his face.

"Hey Professor, isn't it kind of late for you to be up?" Gary asked as he swung through the doorway.

"Blame Billie," I said. "He couldn't find you, so he rousted me out of my bag. Something's wrong on the DiMaggio."

"I know," Gary said, his smile looking even more contrite. "That's my fault."

"Tiant, this is DiMaggio," a crackling voice announced from the monitor. "Just want to repeat our earlier message. We've declared an emergency. We've got a major malfunction in our life-support system. The damn thing is overheating and we can't figure out how to make it stop. Have you got any ideas?"

I looked Gary in the face and he turned as red as liquid iron.

"Mr. Waters, what have you been up to?"

"Professor, I've been a very bad boy. I'll probably get fired for this. Maybe even arrested. But it was the only thing I could think of."

"What did you do?"

"I came down here and got to talking with their engineer officer," he said. "He's a nice guy. From Djakarta. He's got a wife and two kids back home. He wants to make a fortune out here, then go back home and take up fishing full time."

"And?"

"Did you know that the habitat for the DiMaggio has all the same equipment as the habitat here at the station? Extra-G didn't waste money on separate designs. They just packed it a little differently to wrap it around the thrust beam. All the same systems, all the same quirks."

"I think I knew about that," I said. "But what did you do?"

"I just told him about the tech-support message that we got telling us to service our life-support system. You know, the one that got Anika into all the trouble a few weeks ago. The one that made the life-support system overheat."

"You didn't," I said.

"I did."

"And they never got the follow-up message telling them not to?"

"It's only been a few weeks. How fast do you expect corporate to move on something like this?"

"Not very fast at all," I admitted.

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"So I guess the DiMaggio is in trouble."

"It looks that way."

"Do you think we ought to try to help them out?" Gary asked. Now he was beginning to turn giddy. "I figured we'd get them to abandon ship first. That would clear the way for a salvage job. And if we claim salvage, then the supplies aboard would be ours, wouldn't they?"

I frowned. "Have you really thought about what you're doing here?"

"Somewhat," Gary said. "I looked up the salvage laws. Once they've abandoned her, we can move in and salvage everything. We can depressurize the habitat until the life support cools down, then repressurize it and send them back up. In the meantime, we offload our supplies. They get the ship back and go on their way. We get to eat shrimp and chocolate for another six months."

"You know, you can't claim salvage rights if you had something to do with disabling the spacecraft."

"I'm not sure they'll ever figure that out," Gary said.

"There'll be an inquiry. The insurers will want to know—"

"There aren't any insurers," Gary said. "Extraglobal is self-insured."

"And they own the DiMaggio."

"Which gives them even less of an incentive to go digging around into what happened," Gary added.

I shook my head. "I guess you've covered everything," I said. "What are you going to do if corporate finds out?"

"Corporate can go take a nap in the airlock," Gary said. "Three hours ago, they called to tell me they were going to turn Extra-G over to the receivers and let them liquidate the assets. As of tomorrow, we're all free agents. With our salary bonds paid up through the end of next year."

I felt a shudder run up my back. "It's been quite a few years since I've been a free agent. I almost forgot what it was like."

"I kind of like it," Gary said. "I never was cut out to be much of a company man. Even with this jaw."

"To be honest, you never were a very good company man. Even with that jaw."

Gary sneered at me, then said: "You know, I looked up Luis Tiant. He never hit a grand slam homer in the Series. Just a couple of singles."

"Is that so?" I asked.

"I'm afraid it is. He managed to get all around the bases in the opening game. Forgot to tag home until someone reminded him he'd missed it. But no grand slam."

"I was going on memory. It must have seemed like a grand slam to me at the time. I was just a kid, you know."

Gary looked at me sideways. "Just how old are you, Professor?"

"Old enough," I said. "And when you look back on this some day, I'm sure it will seem like you hit a grand slam too—even if it was just a single."

Gary smiled heartily and proudly. "It probably will," he said. "Maybe then I'll be able to enjoy it." ■

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Oven, Witch, and Wardrobe

Tom Sweeney

This may sound a bit familiar—but you probably thought it was fiction!

Siobhan's body prickled from head to foot. She withstood the urge to relieve the itch as long as she could, but inevitably succumbed and rubbed her legs together under the coarse black peasant dress. The overly-long garment had been expertly constructed using only authentic period implements and materials, but as always when it came to time travel, authentic meant uncomfortable and inconvenient. Her own jumpsuit was locked away in another part of the lab. She wouldn't be wearing it again until she returned to now.

A bearded tech, the only other person in the room, frowned at her movement. "Stay still," he said. "And remember to lie in the center of the bed when the TTV returns."

Siobhan rubbed her legs together again under the stiff fabric. "It's too rough," she said. Her voice had risen to a whine, something she detested in others. She forced her tone back to normal, to deal with this reasonably. "Can't I at least wear synth-silk underneath?"

"You go by the rules or you don't go at all." The tech turned and snapped a rough wooden panel into place over a wall-mounted control console. Siobhan couldn't understand the manner with which he fastened it, but the results were impressive. The interior of the Temporal Translation Vehicle was now indistinguishable from a fifteenth-century European peasant hut. Her frame of reference shifted abruptly. The data she had sublimmed earlier came to the fore and she suddenly *felt* she belonged in the fifteenth century.

The tech examined the wall, and evidently found it satisfactory. He stooped and knelt on the floor next to her and Siobhan felt a moment of irrational alarm. He reached under the bed and tugged at something out of sight. Without looking up, he grunted and said, "You don't know how good you got it. No one goes alternate Earth these days,

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and no one—no one—does anything like you're doing." He straightened and eyed Siobhan, frowning disapproval though she sensed more than a touch of envy. He said, "So what do you have on the Director?"

"Maybe she has a heart. I'll save dozens of kids."

He snorted. "You can't save them—they're already dead. You can move them from 1410 to 1692, or whatever the hell you're doing, but who cares if they died six hundred or eight hundred years ago?"

"If I move them, they won't have died from the plague. That alone will make a great news story." She frowned back at him. "Which will help funding, which will help people like you keep your job."

He rolled his eyes. "And just happen to give your career a boost, eh?" He shook his head. "You guys keep fooling around with the 1690's and the stasis lock will bust wide open. Then you'll have a time storm to shake the world, all right." He rubbed his hands together and gave the room a final once over. "Well, it's your funeral, not mine. You have two hundred and ninety-one hours. A little over twelve days. Then you come home."

"Why two hundred and ninety-one?"

"Two-ninety-one point two-seventy-one, actually. The TTV timer counts seconds and the counter has binary registers. When all forty-six registers are filled, the TTV comes home."

"But—"

"Get as many children as you can into the Relocation Chamber mounted in the center of the TTV. Someone showed you how to use it, I hope?"

He didn't wait for a reply. "Put the children in the chamber and turn the handle. They'll be transported to the coordinates that you've supplied."

"The controls—"

"Don't touch them. Spatial and temporal coordinates are preset in both the Relocation Chamber and the TTV. The TTV will return to current time/space coordinates without any help from you. It will give you two hours warning. Be on board or you'll experience the Bubonic Plague yourself first hand. No one will come after you."

Siobhan sat up. "My cat—"

"In a crate in the chamber. What is it with you people and cats, anyway?"

"Hester will make the cottage more homey and help attract children. What are you, afraid she'll kill all the rats in Europe and singlehandedly stop the Plague?"

"No need to act like a witch. Funny, it was a stinking cat that caused us to put the time-stasis lock on the 1690's to begin with. Don't see why you're allowed, but you've gotten your way in everything else." He turned and muttered something mostly unintelligible under his breath, though Siobhan thought she caught the words *witch* and *pain in the ass*.

He walked out of the room. Siobhan lay back down, listening to his footsteps echo in the lab outside. He might as well keep on walking, she thought. As soon as she got into the Director's Office, her first act would be to fire him.

Four children. Twelve days and only four children.

It had seemed such an easy thing to do. Beguile hungry children with food, ship their dirty young butts off to colonial America and return to the twenty-third century to become the first researcher ever to use time travel for humanitarian purposes. And in a manner unlikely to affect history. What could be simpler?

But who would have thought that such young children could be so cautious and untrusting? It seemed they'd rather starve than take food from her. That's carrying fear of strangers a bit far. Ungrateful little pests. Lucky thing for her that she'd smuggled some tea bags and sugar with her under this damned black dress. If it hadn't been for the sug-

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ar, she wouldn't have gotten any of the kids transported and she'd have been humiliated when she returned.

She checked the hidden chronometer built into the TTV's Relocation Chamber. It had already buzzed the two-hour warning and now stood at a mere twenty minutes. Siobhan sighed, gathered Hester into the crook of her arm with a quick scooping motion and made the TTV ready for recall. She would have something to say to those bumbling techs, too. Morons.

"How could they, Sweetie?" she asked the cat. "How could they be so stupid. No, not stupid. That would be an excuse. Now I have to suffer for their incompetence."

Holding firmly to keep the wriggling cat from escaping and running into the woods before recall, Siobhan walked to the window and looked out. Woods, woods, woods. The village near which the techs were supposed to have positioned her was over an hour's walk away. Five hundred meters, she had told them. Close enough to be accessible, but not so close that the cottage's sudden appearance would be noticed.

They had missed by an order of magnitude.

So much for her fast track to the Director's chair. Siobhan tightened her hands at the injustice of it, until the cat hissed, protesting the increased pressure. Siobhan relaxed and kissed the top of Hester's head.

"It's just not right, Sweetie. One chance and look what happened."

"Ye-ow?" The cat tried again to escape.

Siobhan held Hester up to her face for another kiss. Hester turned her head to look out the window. The cat's eyes narrowed and glinted hungrily.

"Oh, no. You're not going to eat another bird." Siobhan shuddered. "That was so gross."

She looked out the window, and saw, not a bird, but two children entering the clearing in front of the cottage.

"Oh! Oh, two more. That'll help." Siobhan hurried to the back of the TTV, where she had already prepared for her departure. Quickly she put the last of her sugar into a leather bag and pulled the drawstring tight.

She heard a knock on the door, then excited whispering. She shoved Hester into the passenger compartment at the rear of the TTV and left the door open just enough for her to get air, but not wide enough to permit escape.

She hurried to the front door and opened it just in time to see the two children leaving.

"Oh, wait. Wait, children. I have something for you."

The boy brightened. "Do you have more of that powdered honey?"

Powdered honey. Each day Siobhan left a little of the sugar in the area of the cottage. Most of it disappeared by the following morning, but only seven children were brave enough to ask for more. All of them had called it powdered honey. The first three had escaped before Siobhan realized that using trickery and brute force was the only way she would save anyone. Trick them into the cottage, shove them into the Relocation Chamber, and send them to Colonial America, where her research indicated that parentless children would be absorbed most readily, and with fewest questions, into the community. A time period that was coincidentally time-stasis locked against ripples in the time fabric.

"Well, do you?" asked the boy.

The girl tugged at his arm. "Let's leave," she said. "I don't like it here."

The boy shrugged her off. "Then go if you want, Gretel. I'm going to get enough powdered honey to fill my pockets."

"Remember Klaus and Maria," Gretel said. "No one saw them come out."

For the first time, the boy looked doubtful. Siobhan intervened quickly before his nerve flagged.

"Klaus and Maria, yes," she said. "I re-

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member them. They came yesterday and stayed late. Klaus had a huge bag of powdered honey. He wanted to hide it so that he could trade it later for a knife." She lowered her voice into a conspiratorial whisper, "I'm leaving soon, you know. And bringing my honey with me."

Siobhan sighed dramatically. "Though there's so much of it. I'd just like to leave it all here with someone."

"I'll take it," the boy spoke up.

"Done," said Siobhan, "but it will take the two of you to carry it, there's so much. I have it here." Siobhan walked to the Relocation Chamber.

The boy grabbed Gretel's hand and tugged, but she held back. "Hansel, that's an oven. She's going to bake us!"

Hansel pulled her along. "I'll protect you. Here—help me carry the honey."

Siobhan opened the door to the chamber, shielding the opening with her body so that the children wouldn't see that it was empty. She reached back. "Come here and help me."

Instead of a youthful helping hand, a streak of black flashed by, and Hester leaped up into the chamber.

"Hester, come here," Siobhan whispered. The cat sat in the back of the chamber, out of reach, and licked a paw. "Hester!" Siobhan hissed.

The kids fidgeted behind her. If she didn't act quickly they'd leave. And these two were truly her last chance. Recall was now only a few minutes away.

Still blocking the front of the chamber from the children's view, Siobhan reached for the old straw broom that was one of the period props. She poked the broom into the chamber and pushed at Hester with it. "Come out of there!"

The cat dodged, but Siobhan edged her body halfway into the chamber and maneuvered the broom around behind Hester. She started to lever the cat out, but in the process exposed the chamber to the children's eyes.

"Hansel," Gretel screamed. "A cat! She's baking a cat. She's going to bake *us!*"

Siobhan felt a shove from behind, propelling her further into the chamber. Her feet were lifted and she was pushed the rest of the way in. The door slammed shut.

She tried to reach the door latch, but the cylindrical chamber was too narrow for her to bend double. Outside she heard muffled voices.

"—the latch?"

"I don't know. What's this?"

A deep clunk shook the transportation chamber. Something whirred low down on the scale then rose in volume and pitch until it was a high whine. Siobhan recognized the sound. The Temporal Generator was building up a charge. The children had turned the handle.

Hester rubbed against her chest and Siobhan managed to gather her up. "No more cat food for you, Sweetie. Not where we're going. It'll be mice and birds, or nothing."

The whine rose above the audible level and Siobhan knew that in seconds she'd be in Colonial America. In a few minutes, when the timer reached zero, the TTV would automatically return home from this time period. Empty. No one would know that she'd been transported to Colonial America. No one would have any idea where to look for her. Not that they would even try. That stupid tech had warned her about that. Specifically.

Well, maybe it won't be too bad living in Massachusetts Bay Colony in the 1690's. Maybe the townsfolk of Salem Village will be kind to a poor old woman who appears out of nowhere, dressed all in black, and carrying no possessions except a straw broom and a feisty old black cat. ■

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SUPERNOVA IN A BOSE-EINSTEIN BOTTLE

A supernova is the explosion of a massive star that is cooling and collapsing because it has literally "run out of gas" by consuming all of its fuel for nuclear fusion. The delicate balance between heat pressure and gravity that holds the surface of a star in place has been upset, and it is avalanching in on itself. This collapse continues until the star reaches a "bounce zone" of nuclear density, where nuclear resistance to further collapse is encountered. There some of the infalling nuclei reverse directions and explode outward, driving the supernova explosion. The remnant that was compressed inward by the bounce becomes either a neutron star or a black hole, depending on the mass of the original star. The whole process is powered by gravity acting on the infalling matter, converting part of the star's mass into energy. (For more details, see my columns on supernovas in the December 1987 and February 1989 issues of *Analog*.)

However, this column is *not* about stars and supernovas. It is about a mysterious new physics result discovered in the behavior of Bose-Einstein condensates that bears a striking resemblance to a small-scale supernova, including the collapse, explosion, and neutron star formation. I'll begin with a review of Bose-Einstein condensation and quantum spin statistics.

If you turn yourself by 360°, the world you observe when you finish appears to be the same as before you rotated. It is reasonable to think that when an object like an atom is rotated by 360°, it should also return to its original state. All atomic-scale particles have the property of "spin" or intrinsic angular momentum, behaving like tiny tops that must always spin around some axis and never stop. In quantum mechanics the condition of returning to the same state after a 360° rotation requires that spin must be "quantized" into values that are always integer multiples of $h/2\pi$, where h is Planck's constant and is equal to 6.626×10^{-34} joule-seconds. Photons of light, for example, obey this rule by having one $h/2\pi$ spin unit (spin 1) that must always point either along or against the photon's direction of travel.

In the 1920s, therefore, it came as a big surprise when experimental physicists discovered that the electron breaks this quantum rule by having a spin that is $^1/_2$ of an $h/2\pi$ unit (spin $^1/_2$). This means that electrons (along with quarks, neutrinos, protons, neutrons, and many atoms) are *not* the same after a 360° rotation. They must be rotated through two full turns or 720° before they return to their original states. This peculiar spin behavior is not well understood, but it is nevertheless an accepted fact of quantum physics.

The distinction between particles with integer spin (like photons, mesons, and ^{4}He nuclei) and half-integer spin (like electrons, quarks, and protons) is very important in the fields of atomic, nuclear, and particle physics, because the two classes of particles have distinctively different behaviors. The particles

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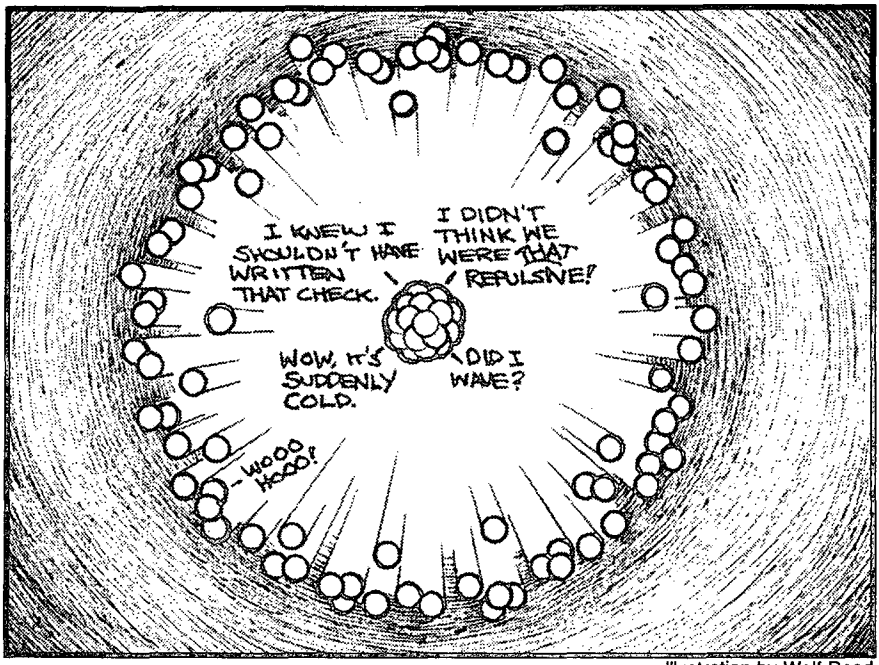

Illustration by Wolf Read

with half- integer spin have the statistical behavior first described by Enrico Fermi and Paul Dirac and are called "fermions", while integer spin particles are called "bosons" and show a statistical behavior first described by S. N. Bose and Albert Einstein.

Fermions obey the Pauli Exclusion Principle, behaving like highly territorial individualists, with only one particle allowed in each unique quantum state. If one fermion occupies a particular quantum "box" described by its spin orientation, momentum, and position, then all other identical fermions are excluded from that box.

In contrast, bosons in the same box tend to congregate together, with other identical bosons "invited in" to share the same box. As more bosons pile into the box, the tendency for others to join them becomes stronger and stronger factorially. If a group of identical boson atoms having integer spins are tightly confined in a "bottle", trapped in a particular location by a combination of magnetic fields and intersecting laser beams, and cooled to a temperature of nearly absolute zero, they can form a Bose-Einstein condensate. This is a unique state of matter, predicted in 1924 but not observed until 1995, in which all of the participating atoms share the same quantum mechanical wave function. (For more details on Bose-Einstein condensates, see my column in the March 1996 *Analog*.)

Any group of identical atoms having integer net spin can be used to form a Bose-Einstein condensate. However, those most often used are the alkali-metal atoms that reside in the first column of the periodic table. These are bosons because their half-integer electron and nuclear spins combine to give them an overall integer spin. To form a condensate, such atoms are collected as boil-off from an oven, then cooled in a succession of atomic "holding pens" or traps, while the hot atoms are removed by evaporation and the energy of the survivors is reduced with laser cooling. In

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the experiment described here, the atoms are ultimately held within a cryostat—a super-insulated thermos-bottle that shields them from external heating, at the center of a "baseball coil" trap.

The baseball coil is an electromagnet wound so that the current-carrying wires trace a path like the stitching of a baseball, producing magnetic field lines that come in from two directions along one axis and exit in two perpendicular directions along another axis. Also, an outer solenoidal coil superimposes a uniform field of a few hundred gauss on the twisted field of the baseball coil. The very cold alkali-metal atoms are held near the center of this system, where the baseball coil creates a very large magnetic field gradient. Then, under favorable conditions, perhaps a million atoms of identical boson alkali metals will form themselves into a Bose-Einstein condensate.

Until recently, the experimenters had no control over the force that acted between the atoms of the condensate. They had to take whatever interaction force their atoms gave. However, Carl Wieman and his group at the University of Colorado have introduced a new trick. By using the isotope rubidium-85, they have produced a Bose-Einstein condensate for which they can "dial in" the interaction force between atoms. They can even switch the force from repulsive to attractive. This is possible because at just the right energy, atoms of ^{85}Rb happen to have an interaction that is dominated by a magnetic field dependent "Feshbach resonance", a reversible energy-dependent rearrangement of the quantum states of the colliding atoms. Slightly changing the overall magnetic field of the trap in which the Bose-Einstein condensate is confined shifts the energy position of this resonance, thereby changing the strength and the sign of the force between the interacting atoms. The downside of using atoms of ^{85}Rb, however, is that they are difficult to compress and cool. Therefore, their ^{85}Rb condensate contained only about ten thousand atoms instead to the million or so atoms they could have achieved with more cooperative atomic species.

The ability to select the strength and sign of the atomic interaction provides remarkable experimental possibilities for studying this Bose-Einstein condensate. It's the equivalent of studying the astrophysical properties of a star while being able to change the strength of gravity and to switch from gravitational attraction to repulsion.

Wieman's group, using a Bose-Einstein condensate with about 10,000 atoms of ^{85}Rb held in a magnetic trap, was able to achieve the super-low temperature of about 3 billionths of a degree above absolute zero (3 nK). This sets a new world's record as the lowest temperature for a group of atoms ever achieved in the laboratory.

They started by setting the overall magnetic field to 162.6 gauss, a field at which the force acting between rubidium atoms was slightly repulsive. When they rapidly changed the overall magnetic field to a value of greater than 166.8 gauss, the force between rubidium atoms became attractive, and they observed a remarkable behavior. The Bose-Einstein condensate first began to collapse, but then it "bounced" and exploded, leaving behind a cool remnant.

The behavior of this Bose-Einstein condensate system bears such a striking resemblance to a supernova that the experimenters christened it a "Bosenova". However, in a supernova explosion, the physical processes are relatively well understood. In contrast, the most surprising thing about the Bosenova is that the underlying fundamental physical processes behind the explosion are still a mystery. About half of the atoms in the condensate seem to have disappeared from the experiment altogether and are unaccounted for, not seen either in the cold remnant or the expanding gas

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cloud.

Moreover, the "bounce" that follows the initial collapse is completely unexpected. Known physical processes that would interfere with the collapse should occur at scales several orders of magnitude smaller than that observed. "Understand," said Carl Wieman, "that atoms have been very well studied. Essentially all the behavior of atoms in general and BECs (Bose-Einstein condensates) in particular, we thought were quite well understood, and could be accurately predicted with theoretical calculations. Even for those features that cannot be accurately predicted, the basic physical processes are still qualitatively well understood. But the theoretical calculations of what would happen in this situation predict behaviors that are totally unlike what we've observed, so the basic process responsible for the 'Bosenova' must be something new and different from what has been proposed."

The work raises a number of open questions. How cold is the "neutron star" remnant left behind by the Bosenova? Its temperature has yet to be measured, but it may be much colder than the world-record 3 nK temperature of the condensate before the collapse was initiated.

The fate of the missing atoms also remains a mystery. The researchers suspect that either these are accelerated so strongly that they escape the atom trap undetected, or they form molecules that are invisible to the detection system. The source of the energy that powers the explosion is also mysterious. How can the coldest system of atoms ever produced in the laboratory suddenly find the energy to mount an explosion? What is the source of the energy driving the explosion? Why don't the known laws of atomic physics seem to work for this system?

Watch this column for further developments on the mysteries of Bose-Einstein condensates. We have much more to learn. ■

AV Columns On-line: Electronic reprints of over 100 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available on-line at: *http://www.npl.washington.edu/av.*

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Knowing how to win is the first step. We must also know how to make use of our victories.

—Polybius

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When you discover something new, you'd probably like to (1) understand it, and (2) learn to use it. Sometimes you can have one without the other. . . .

Going, Going, Gone

Stephen L. Burns

Illustration by Randy Asplund

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"That's not really a Chippendale chair, David, it's a copy." Lola spoke quietly—and it seemed to Dub just a little smugly. It was the voice of an expert watching amateurs getting snookered. Two citified women seemed to disagree with her appraisal, and had bid the price up past $500.

"If you say so," Dub agreed. While his driver's license read David Urbanski, just about everybody except Lola called him Dub. Normally he preferred Dub, but her using David was kind of nice. It meant she didn't see him as the same old Dub as everybody else.

As for the chair, he really didn't give two hoots about the damn thing. All he wanted was for the bidding to be over so the next item could come up. Lola was the antiques bug, always researching them in books and on the internet, and watching every show about them on TV religiously. Personally he thought most of the stuff was old, overpriced junk.

But then again, you could sometimes find some really fine older items at these things, he mused, slyly contemplating his companion's trim figure. At age sixty-two, she still had the energy—and the body—of a woman fifteen years younger. He'd met her at one of these estate auctions. His lucky day had been the one where she'd asked a certain old guy with a pickup if she could hire him to haul this big ugly sideboard she'd bought home for her. Disagreement over payment had been carried on into a dinner out, then bloomed into a really fine romance.

"Sold for six hundred and fifty dollahs!" bellowed Cork Habeeb the auctioneer, slamming down his gavel. "Next up, lot 73." He grinned and shook his head. "Most of you know that every six months, Claire Axelrod puts another big heap of her late brother's stuff up for sale. And every so often we get these boxes of, well, *stuff*. I gotta tell you, I have no idea what this stuff is. But we know that Eton Axelrod was a world traveler, and something of an inventor. This stuff *could* be valuable! So let's open the bidding at ten dollars! Do I hear *ten?*"

Dub let it hang there for a few seconds, then raised the paddle he and Lola shared.

"Dub Urbanski's offering ten!" Habeeb crowed. "Now do I hear *twenty?*"

Dub waited patiently, doubting he would.

"Ethel called this morning," Lola said in that *this is important information* tone Dub had learned to recognize in the six months they'd been an item.

"How's she doing?" he asked, squirming in the truck seat like a boy fielding a hard question from his teacher. There was no safe response to this statement, and he dreaded the subject that was bound to follow it.

"Just great! She can't say enough good things about Arizona."

A heavy pause. Dub kept driving, praying for a distraction as he rode the silence out.

Lola turned to face him, her expression serious. "I really want to move there, David, and I don't want to have to do it alone. Winter's coming, and I can't face another year of fighting the cold and snow. If we sold both our places, we'd have enough to get something really nice. And think of the advantages. Warm weather. No big heating bills. No shoveling snow or scraping windshields. Only one set of property taxes." Her hand settled lightly on his thigh. "Being together all the time."

The idea was tempting, no doubt about that. His house had seemed to double in size after cancer took Mary five years back. Since then his life had been, if not grim, at least a little on the glum side until Lola came along. Throwing in with her permanently would be a smart move. She had looks, money, and a way of making life fun again. Factor in

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the sort of sex life he hadn't enjoyed since he was in his twenties, and regularly getting to eat something other than his own cooking, and it was an unbeatable offer. Only a fool would pass it up.

The problem was that while some guys got antsy when they passed sixty and retired, he wasn't one of them. All he'd ever wanted to do was hunker down in a familiar place, near people he knew, and allow himself to do some of the things that life as a working stiff had never given him time for.

Lola's message was getting louder and clearer every time she brought this up. She was edging closer to the point where she'd go without him. The idea terrified him, but he just couldn't seem to come to grips with pulling up stakes and moving.

The silence was starting to drag on when Dub spotted salvation. "Hey, look! A new roadside stand! Looks like they've got a mess of winter squash, and maybe some antiques. Want me to pull over?"

Like most women, Lola could not resist fresh vegetables. Adding antiques to the mix made it irresistible. "Would you?" she asked hopefully.

"Sure thing." He eased his big Jimmy pickup into the dirt parking lot—and away from a line of talk telling him he was getting closer to a *move it or lose it* situation. That was well worth the price of several meals pretending he liked squash.

The moment he'd been looking forward to all day finally arrived. He was alone in his cellar workshop with the big Mystery Box he'd bought at the auction.

The Eton Axelrod Recurring Estate Sale was one reason he'd sure hate to move away. Axelrod had been rich, brilliant, and either seriously eccentric or totally crazy. Or maybe a bit of both. He'd died back in the early nineties. A couple years later, his sister Claire (something of a bedbug herself) had begun selling his stuff off piecemeal. About every six months, another big pile of items winnowed from his rambling mansion and five immense storage buildings would go on the block.

Not normally an antique sale sort of guy, Dub had gone to the first one because he'd heard that Axelrod had collected, among other things, antique telephone equipment. Thirty-five years working the lines and switching stations for the phone company had made a collector of Dub, too.

One of Axelrod's innumerable quirks was finding odd devices, disassembling them, and putting the pieces in boxes. No one knew why he did this any more than they knew why he had a refrigerated swimming pool in his cellar and a completely disassembled Tucker in his attic. On a whim Dub had bid on his first Mystery Box at that auction, paying five bucks. Its contents, when carefully reassembled, proved to be a working mechanical abacus-type adding machine; a device so odd and rare it had taken an antique dealer friend two months to find out anything about the thing, and then come up with a jaw-dropping appraisal. Dub went to the next sale, and got a box that had all the makings of a miniature working steam calliope small enough for a flea circus. From then on, the lure of the Mystery Boxes was irresistible.

Lola was safely back at her house, trying to decide where to put the butler's table she'd bought at the auction. Dub knew that could keep her happily occupied for hours. The coast was clear. So he started a pot of coffee brewing, then went to the cabinet marked HAZARDOUS MATERIALS and retrieved his pipe and tobacco.

Once he had his pipe nicely going and a cup of hot joe standing by, he removed all the items in the box and spread them on his worktable.

Dub had worked on things all his life: phone equipment, cars, mowers, homebuilt stereo equipment, you name it. But the collection of parts waiting to be reassembled weren't like anything he'd

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ever seen before. Many of the pieces were these short sections of curving hollow tube. Others were glassy spheres with places in them where it looked like the tubes might fit. There were maybe sixty pieces in all.

Having worked on Axelrod's disassemblies before, he started out by carefully examining each piece to see if it might contain one of the notes the man had sometimes squirreled away.

There inside one of the tube thingies was a rolled-up scrap of paper. He flattened it out and adjusted his reading glasses to help decipher Axelrod's mad crabbed scrawl.

of crse! evnt in shra wd go unotcd! wht funct? fuel? defns? coll of raw mat? econ poss usd in rt area? sprse 4 nbrs othrws! st up near clre? STOP at yelow! get more: beans, brndy, banans, brocli, bran, brn rice, brms, budwsr

"Well, looks like you've handed me a poser this time, Eton," Dub said, scratching his head in bemusement. The notes were always cryptic, and quite often didn't make any sense until the device they described was reassembled. Only one part of the note was immediately comprehensible, and that was the last sentence. The man habitually finished these notes with a grocery list, and only bought items starting with the same letter on trips to the store.

Dub's pipe was going good now, and his curiosity was just as stoked. Time to begin puzzling out what kind of pig in a poke he'd bought.

"David! Yoo hoo!"

Dub started in surprise, then guiltily stuffed his cold pipe in his pocket. "Down here," he called, glancing at his watch.

Oh man, it was nearly six. He'd gotten so wrapped up in trying to figure out how the thing went together, that the afternoon had just vanished.

Lola sauntered down the stairs, dressed in slacks, a nice blouse, and leather car-coat. She took one look at his smudged hands and dirty clothes, sighed. "David. Did you forget?"

They had reservations for dinner at the little Italian place downtown. "Uh, no," he began, but since he wasn't any damn good at lying, tried to explain himself instead. "I just lost track of the time, that's all." He offered an apologetic smile. "Give me ten minutes to get cleaned up and we can go."

"OK." Lola peered at the object which was slowly taking shape on his worktable. "What is that thing, anyway?"

"No idea," he admitted. "Probably won't know until I get it back together. Even then I may only know if it still works."

She gave him a wry smile. "You really get off on projects like this, don't you?"

He shrugged. "I guess so. Sure."

"And you probably would've worked all evening if I hadn't showed up."

"I might've." Actually, it was almost certain. The thing was finally beginning to come together. There was a certain screwy symmetry to the shape it was taking. Plus the various parts were made in such a way that it could not be misassembled. Any two parts which looked alike on casual inspection were subtly different enough that they would only go together one way.

Fortunately, Lola seemed more amused by his obsession than anything else. "Tell you what. We can still do dinner, but we'll go in separate cars. Afterward, I'll run over to Blairville and visit Suze Waltrip for a while. I've been promising to drop in, but lately I've been spending so much time with this big dirty-handed stud I know, that some of my old girlfriends have gotten lost in the shuffle. You can come back here and tinker to your heart's content."

Dub gave her a grateful smile. "Really? You don't mind?"

"I could manage if I was sufficiently motivated. Like by knowing that if I got back here around eleven or so, you'd be ready to maybe concentrate on me." She

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struck a pose to make her meaning clear.

He gave his girl a cautious hug, not wanting to get her dirty. "I promise you'll have my full and undivided attention."

Form follows function—and function follows form. Usually once Dub got one of Axelrod's mystery machines partly assembled, its shape and use started to become clear.

Stuffed with lasagna and puffing contentedly on his pipe, he contemplated the device he'd reconstructed in bemused bafflement.

He had to admit that he was flat-out stonkered by this one. It didn't resemble anything he'd ever seen before. The base of the thing was an outer ring about the size of a Buick hubcap, the tubing an inch or so in diameter. Several smaller tubes, some attached together by knobby spheres, connected that with a six-inch sphere in the middle and about the same distance up from the tabletop. A rod came out of the top of the central sphere, with a knurled disc on top of that. The rod seemed to be the only movable part, which suggested that it was the control for the thing.

But what did it control?

He glanced at his watch. A few minutes past ten-thirty. Lola was going to be along directly. If he was going to try the thing out, it had to be now, or else wait until morning.

"Aw, what the hell," he said with a shrug. Curiosity was killing him.

He took hold of the disc. Nothing happened. It didn't seem to want to turn, either. So he carefully tried pushing in on it.

The disc and rod assembly slid deeper into the body of the central sphere, stopped. There was a muted tone, and the outer ring began to glow a deep red. In the space between the outer ring and central sphere, a dome-shaped film of bluish light flashed into being. He pulled his hand back in surprise. The control disc stayed where it was.

"What the hell *is* this thing, a fancy nightlight?" he growled, appealing to the ghost of Eton Axelrod. No answer came.

Dub was of the "poke things with a stick first" school, so he tried probing the glowing blue stuff with a screwdriver. It met no resistance and set off no sparks. Pulling it back out, he tested the blade. Cool to the touch. Next he risked a fingertip. No sensation from touching the light at all. The red ring remained cool to the touch as well.

He took hold of the disc again, and found that now that it had been depressed, it was also rotatable. There was only one way to find out what giving it a crank would do.

Turning the disc slightly caused another, higher tone to sound, and the outer ring began to change color, brightening from a dull red to orange. More turning and it started changing from orange to yellow.

"*Stop at yellow*," Dub muttered, now understanding one of the cryptic entries on the note. Just to be on the safe side, he dialed it back to orange.

Still nothing that he could see, hear, or figure out seemed to be happening. Just as he was leaning over to peer more closely at the outer ring, he heard someone go *Ahem.*

He looked up, found Lola standing on the stairs. Blinked because she wore only black stockings, a flower in her hair, and a look that said she expected to be noticed.

"You done messing around with that thing for the night, David?" Her voice was sultry, teasing.

"You bet!" he agreed with a big grin, starting toward her.

"Then follow me." She turned and started up the stairs.

Dub went after her, all thoughts about the Mystery Machine suddenly gone from his mind.

Just about the time Dub had started proving that not all old farts needed Via-

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gra, a soft chiming sound filled the basement.

Two small white dots appeared on the outer edge of the blue dome, right where it met the outer ring, and about a third of the way around from each other. Concentric rings like ripples spread from each of these dots, then faded to the sound of another chime.

Then the two dots began creeping slowly toward the central sphere.

Getting ever so slightly brighter and larger along the way.

Dub lived a mile or so out from Rocklund, and the area hadn't yet been completely subdivided and suburbanized. The big lot across the road was vacant, and belonged to him. The neighbors on either side were both a few hundred feet away.

When a man has privacy like that, it's hard to resist taking a wee hours pee call outside. It was a chance to check out the stars and look for Northern Lights. To commune with nature, and get a handle on the next day's weather.

Dub stood there, blissfully watering a honeysuckle bush. Although only dressed in a ratty old flannel bathrobe and slippers, he really didn't mind the thirty-degree air on his bare legs. The waning Moon was low on the horizon. An owl let out a mournful *whoo* from somewhere on the ridge out back. The peace and quiet were perfect.

At least until he spied a spark cutting an arc through the air.

Shooting star, was his first thought. *Ought to make a wish.*

Then it dawned on him that the meteorite was heading in his general direction. *Fast.*

Before he had time to do more than hastily stow his equipment and briefly consider the chances of a man his age with one bum knee outrunning a meteorite—and just about decide maybe he'd take a shot at it in spite of the astronomical odds—it flashed overhead.

There was a sharp *ca-rump!* as it came down in his neighbor Ben Thorne's yard. More precisely, in his driveway. More precisely yet, slamming into the hood of Ben's month-old, 18-horsepower John Deere garden tractor.

Dub witnessed the whole thing. The meteorite hitting, and then the mower going up like a mortar round had hit it.

"*Holy cow,*" he gasped, starting first toward Ben's yard, then thinking better of it and heading back to his place to call the fire department. The burning mower was awfully close to the house, and it looked like it might have a full tank of gas.

He'd made the call, and was just getting ready to head back out and run next door, when Lola stumbled into the kitchen, wrapped in a blanket and blinking against the light. "David? What's going on?" she asked in a voice furry with sleep.

"A meteorite just hit next door! It killed Ben's riding lawn mower! Blew it all to hell and set it on fire!"

She stared at him uncomprehendingly. "What?"

This was one of those situations you couldn't really explain to someone half asleep, and time was wasting. He made a shooing motion with his hands. "Go back to bed, hon. I'll be along after the fire trucks arrive."

He didn't wait to see if she did as he suggested, instead grabbing a flashlight and racing off to help. When he was halfway across the yard he saw another meteorite come down, this time hitting in the lot across the road.

"The goddamn sky is falling," he puffed, not sure if he should be frightened or not. That was something he'd have to figure out later.

"One hell of a thing," Ben said dolefully, shaking his head as he stared at the steaming remains of his all but new Deere.

"Sure is," Dub agreed. "Think your insurance will cover it?" Since Thorne was an insurance agent, he figured there was

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a better chance at coverage for him than most folks had.

Mick Dorr, the Rocklund Fire Chief, joined them before Ben could answer. "Well, she's out," he announced, pulling off his helmet and wiping his face. "What started it, Ben? Did you leave her running or something?"

"A meteorite hit it," Dub explained helpfully. "I saw it happen while I was taking a leak out in the yard. Called it in, too."

"A meteorite?" Mick said, clearly thinking Dub was pulling his leg. "You're shitting me, right?"

"No sir. Another one came down across the road. Since it's mostly sand over there, no harm done."

Chief Dorr shook his head. "We didn't see no meteor, Dub."

"Did you look for one?"

"Can't say as we did. They ain't on our list of usual causes. Ain't even on our list of *un*usual causes."

Dub held out his hands. "Loan me your gloves a minute. I'll see if I can find it."

Mick thought about it a second, then shrugged. "Sure. This I've got to see."

Dub approached the ruined machine, his slippers quickly getting soggy in the water puddled around it. The stone from the sky had hit the hood dead-center. But there was no hood left now—the fire had burned it away to nothing. He fished the flashlight he'd grabbed in the kitchen from his pocket, shined it on the engine. It was such a mess that it was hard to tell for sure, but it looked like a big hole had been blown in the flywheel cover.

Crouching down, he felt around under the machine. The mower deck had been removed for the winter and a snowblower attachment put on instead, which made the hunting easier. Mick and Ben came closer as he felt around, soon finding a hole in the asphalt. Probing gingerly, he located a chunk of stuff at the bottom. A little clumsy prying and it came free.

"Here we go," he announced, standing up and wincing as his bad knee gave a warning twinge. He held out a melted lump about the size of an egg. "One rock from the sky."

Mick stared at it, rubbed his chin and whistled. "Well, I'll be damned. That puppy sure must've been *hot*."

Dub nodded. "It was flaming when it went over." He shucked off one glove, wet a finger with his tongue and touched the meteorite. There was no warning sizzle. It was still warm, but not really hot. He tried to hand it to Ben.

His neighbor shook his head. "What do I want it for? You keep it."

That was a tempting offer, but Ben had been a good neighbor over the years. "You better hang on to it. You might need it to prove what killed your tractor. Could be the paper will want a picture of it, too."

"I guess," Ben sighed, cautiously taking the rock. "Thanks, Dub. You better head home now. Otherwise you're gonna freeze your ass off—or worse."

Now that the excitement was over, the lack of pants *was* becoming an issue. "Sure. See you in the morning."

While it would have been tempting to take the meteorite, Dub consoled himself with the knowledge that he had a pretty good idea where there was another one. No sense being greedy.

As he neared the house, he noticed that the cellar lights were still on. Which reminded him that the Mystery Machine was still on too, thanks to Lola's making a better offer.

The night was catching up with him, and it would've been easy to blow it off and just go back to bed. But leaving the thing running unattended probably wasn't all that smart. He could be courting having Mick come to his house next.

The thing looked pretty much like it had before. Or so he thought, until the very moment he was pulling the control rod back up to turn it off. Just a fraction of a second before the rod clicked into

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the up position, he spotted two small dots inside black boxes at the top of the blue dome, about 120 degrees apart. No sooner had he seen them, than the dome vanished and the outer ring went dark.

He briefly considered turning it back on to see if he could figure out what that meant, but he was cold and tired. He had a choice between hanging out in wet slippers in a cool cellar, or going back upstairs and climbing into bed with a warm woman.

"G'night, machine," he said, then turned and squelched back up the stairs.

One of the many reasons Lola was one gal in a million was that she fervently believed in cooking a proper breakfast. Nor did she get all health-foody about it. Breakfast was hot coffee and lots of it, toast, eggs fried in butter, sausage and hash-browns.

Now and then he'd get tempted to ask if maybe eating like this had contributed to her husband's croaking with a heart attack in his early fifties. But Dub was a practical man. If he'd let himself in for a short life of great sex and serious breakfasts, well, there were plenty worse ways to go.

Usually they watched the news as they ate. The TV was on, but just as much news was happening out the window. From the dining nook, they could see the cars and TV trucks parked in Ben's yard. A CBS truck had already come and gone, and the untimely death of Ben's John Deere had made *The Early Show*.

"You mark my word, that meteorite will be worth something," Lola said as she poured them each some more coffee.

He turned back from the window. "Really?"

"Sure," she said. "I saw a segment on *The Eclectic Collector* about meteors and meteorites. There's a constant market. Ones with a story attached to them, like Ben's, will fetch a good dollar. Sometimes a museum will buy the meteorite and whatever it hit for a display."

Dub shook his head in amazement. "I had no idea."

"You said you told Ben to hold on to his?"

"Yeah, I did."

"That was nice of you." But a faint note in her voice hinted that he'd should have grabbed it when he had the chance.

"Well, it landed in his yard and killed his tractor. Besides, I'm pretty sure I know where there's another one."

Lola's cup stopped halfway to her mouth. "*Another* one?"

"Yeah. I saw it fall just after I called the Fire Department."

"You never said! Where is it?"

He waved a free hand as he raised his cup. "Somewhere across the road."

"Really. You own that property, don't you?"

"Sure do."

Lola stood up. "Well, then come on! Let's get our butts in gear and go meteorite hunting!"

Half an hour later, Dub was poking around in the scrubby patches of grass and brush with a stick when he heard Lola yell. "Hey! I think I found it!"

She was standing in front of a place where the sandy soil was pocked by a small crater. Bits of scorched grass surrounded the edge.

"Good hunting, darlin'," he said with a grin, kneeling down and probing around in the hole with the trowel they'd brought along. The blade clunked into something. "Think we've got it."

What he unearthed was a potato-sized and-shaped lump of dense black stuff. It was surprisingly heavy, and he said so.

"That means it's metal—probably nickel-iron," Lola explained. "Was the one that hit Ben's mower like that?"

"Naw, his was more like rock."

"He's lucky this one didn't hit his house. It's a bit bigger and heavier than the other, and would've caused a lot of

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damage."

"Yeah, I think my neighbor got enough of a surprise for one night." Dub frowned as those words left his mouth. Why did they sound so familiar?

"Five hundred feet that way and it would've hit *your* house," she pointed out. "Same for the other one."

Dub turned to stare at his place. "Two close ones in one night. Kinda makes you wonder, don't it?"

Lola had an appointment at the hairdresser for later that morning. She headed out for that, planning to take the meteorite back to her place afterward. There she could weigh it, take some digital photos, and start checking to see what it might bring on the internet. Not that they were in any hurry to sell. She was just going to scope out the current market for such things.

That was OK with Dub. It meant that after a few chores he could go back to trying to figure out what the hell his latest buy might be.

After lunch, he settled back in his basement with a stoked pipe and the radio tuned to a classic rock station, then pulled up a stool and considered his options.

He could take the thing apart and put it back together again. Sometimes reviewing the interconnections and relationship between the different parts helped make their function finally come clear.

But he had a feeling that wasn't going to be much help this time. It wasn't like the thing had gears or pipes or wires. He didn't even have the slightest idea what gave it the power to light up. Hell, major portions of it were hollow.

Yet old Eton Axelrod seemed to have known what it was. Which meant that he'd doped out what it did. For lack of a better approach, Dub retrieved the old loon's note and reread it.

of crse! evnt in shra wd go unotcd! wht funct? fuel? defns? coll of raw mat? econ poss usd in rt area? sprse 4 nbrs othrws! st up near clre? STOP at yelow! get more: beans, brndy, banans, brocli, bran, brn rice, brms, budwsr

Wait a minute. What if **sprse 4 nbrs** meant *surprise for neighbors?*

Well, Ben sure had gotten one hell of a surprise. If there had been anyone living across the road, they would've gotten one, too. He puffed his pipe, his thoughts veering off toward a damn strange conclusion—

—that his new toy had somehow *called* those two meteorites.

That seemed pretty damn unlikely. How did you call a meteorite? By whistling, or putting down a nice bowl of Meteorite Crunchies? And how would you steer one?

"Right," he muttered, chuckling to himself. Two meteorites falling within a few minutes of each other, and both landing about five hundred feet from his house was just one hell of a coincidence. They said lightning never struck the same place twice, but anyone who worked on the phone or power systems knew better. Hell, he not only knew places that had been hit more than once, he knew people.

Still . . .

He shook his head. This was getting him nowhere. His best bet was to see if those two boxed marks were still showing on the dome. Maybe they'd tell him something.

After a pause to relight his pipe, he pushed down on the rod to start the thing up. The outer ring lit and the blue dome sprang back into being. Sure enough, the two boxed dots were still there. But unless he was mistaken, they seemed to have moved since last time. One just a little, one quite a lot.

Their placement on the dome had to mean something. But what? Just for the hell of it, he grabbed hold of the outer ring and rotated the whole device about ninety degrees.

The two boxed marks stayed where they were relative to the room. One

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stayed on his side, a ways out from the handle. The other remained on the other side of the handle, in fairly close.

He eyed the far dot, then the cellar wall past it. A chill went through him when he realized that if he struck a line made from the central handle and that dot opposite, then followed it, the line would go to Ben's house.

An uneasy laugh escaped him. So much for that. The meteorite had fallen in his front yard.

"But he's probably keeping it inside now," Dub whispered. He laughed again, getting creeped out. Just another coincidence. There was even an easy way to prove it. All he had to do was prove that the line made by the other dot didn't lead anywhere.

He reoriented himself, got his bearings, then closed his eyes to visualize the lay of the land. One thing came clear pretty quickly.

If he followed that line he'd end up at Lola's house. Which was further away from him and the machine than Ben's.

He shook his head in denial. "Can't be. There's no earthly way to build a machine to attract and track meteorites."

The conclusion that hard fact led him to sent him stumbling toward the coffee pot. His hands shook when he filled the cup.

When he went back to his worktable, he shut the machine off, slumped onto the stool, and began some hard thinking.

Dub was still sitting there, bleakly staring at the device, when Lola returned late that afternoon. Several pipes-full of tobacco, two pots of coffee, a candy bar, and several hours of serious skull sweat had gotten him exactly nowhere.

"Hey, guess what?" she said, coming up behind him and giving him a big hug. "We might be able to get a hundred bucks for that meteorite. Maybe even more."

"Really?" The hug felt good, and helped him shake off a bit of his peculiar mood.

"Isn't that a great deal? Pick up a rock and it's worth real cash!"

Dub's mood skidded back toward sour, greased by guilt. "Not such a hot deal for Ben. His rock cost him several thousand dollars worth of machinery."

Lola came around beside him. "Don't worry about Ben. I just saw his wife in the driveway. They're coming out of this way ahead. Their insurance company will replace his mower, plus they've offered big bucks to use the rock in a bunch of commercials. '*Stones from the sky? We've got you covered!*' That sort of thing."

He let out a sigh of relief. "That's great. I'd feel awful otherwise."

"Why? You not only called it in and maybe kept his house from catching fire, you also made him keep the rock."

"Yeah, I guess."

She studied his face a long moment, clearly seeing that he was troubled, then let the matter drop. "So how are you coming with your new toy? Have you figured out what it does yet?"

"Still trying to figure that out," he answered evasively.

This time she gave him a long hard look, a frown working its way onto her face. "But you have an idea, don't you?"

"What makes you say that?" He tried to keep a defensive note out of his voice, but pretty much failed.

"Listen, David," she said with a sigh. "I spent almost twenty-five years as a loan officer at a bank, and I had a husband who was prone to fooling around with his female employees. I can tell when somebody's not telling the truth." Her face softened. "With you it's even easier. You're about as honest and upfront as they come. Except for trying to let me think you gave up that stinky old pipe of yours, you've always been straight with me."

He eyed her uncertainly. "You know I still smoke sometimes?"

She snorted. "Sure. Peppermint Lifesavers don't really cover the smell of

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Captain Black."

"Sorry."

"Every man needs at least one secret vice. So come on, tell me why you're acting so down. Or what you think this thing is. Stop being a big clam, OK?"

He considered a moment, nodded. "OK. Promise not to laugh?"

"No," she shot back with a grin. "Not when it might make you laugh, too."

That made him smile. "OK, lady, you asked for it. But I warn you, it's pretty off the wall . . ."

Dub laid it out as best he could. Lola had a hard time believing him until he briefly turned the thing back on. She'd brought the meteorite they'd dug up with her. When she walked around the table carrying it, the dot dutifully followed her.

After that, she turned briskly practical, planning their next move and preparing for it in a whirlwind of activity.

That was how midnight found them parked in Dub's pickup, dead in the middle of the long defunct Flynn's Sand and Gravel Quarry way out near the county line. Not parking in the manner of the kids who sometimes went there in summer, but parked as in sitting there with the truck idling to keep warm. A light snow had fallen earlier, but now the sky was clear and the temperature had dropped radically.

"Coming up on four hours now, isn't it?" Lola said as she refilled their coffee cups from a thermos.

"Sure is." That was about the interval between when he'd turned the machine on and Ben's mower had gotten bombed.

Both peered expectantly at the machine, which was propped up on the dashboard. The outer ring was set for a yellowish orange, theoretically a slightly higher power setting than the night before. On the blue dome two white pips continued to move toward the central handle. They were almost there.

"Why would anyone build something like this?" Lola said quietly.

Dub shrugged. "Hard to say. Axelrod's note mentioned a couple possibilities. Could be for defense, though I'm not sure how you'd aim the thing, and it's a pretty long wait after you pull the trigger. More likely it's to gather raw materials for fuel or something."

"You know, it could be for gathering energy, too."

"How's that?"

"Suppose it's part of a larger system. One with a grid or field or something. When a meteorite comes in, it's moving pretty fast, and its impact releases a lot of energy. There are mile-wide craters blown in the Earth, and look at the Moon. What if you could capture and store that energy?"

"I guess that could work." Not that he could see how.

She frowned. "Uh-oh."

"What?"

"I just had a thought. Not a good one."

"Well, spit it out."

"What if it really does attract meteorites, and brings one down on top of us?"

"Not to worry," he said with false bravado. "Eton Axelrod used the thing and survived. The stones that came down last night all landed about five hundred feet away from the machine. We should be just fine."

She didn't look entirely reassured. "There's still one more thing to consider."

"Which is?"

"If we really do call down two meteorites, they're going to be crashing into loose sand and gravel."

"Yeah . . ."

"Impact will be like a small bomb going off. Rocks and stuff could get thrown a long way."

Dub stared at her, a sinking feeling in his gut. "Oh boy." He eyed the machine, wishing he'd never bought the damn thing. "Think maybe we ought to turn it off?"

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She bit her lip, then shook her head. "No, that might not be such a good idea."

"Why not?"

"Well, if it guides them in to a certain place, what might happen if you stopped steering just before they hit?"

He swallowed hard. "They could hit anywhere."

"So I guess we better leave it on."

"And hope the truck will protect us from flying gravel."

This line of thought made them decide maybe it was time for a little snuggling after all. Lola slid over close and under Dub's arm.

Together they watched the machine and waited to see if they results of their less-than-well-thought-out test might end up canceling their subscriptions to *Modern Maturity.*

Lola spotted it first, pointed. "David! *Look!* "

Dub peered through the windshield, various parts of his anatomy puckering and shriveling when he saw the fireball heading right at them.

Lola's reaction was just the opposite. "It *works!* " she crowed, bouncing up and down on the seat. "It really works!"

"I just hope—" That was as far as Dub got before the meteorite flashed past and buried itself in a gravel bank about five hundred feet away. The truck shivered when it hit, and just as Lola predicted, the impact flung a wave of rocks and gravel up into the air. Before Dub even had time to get a halfway decent flinch worked up, debris was coming toward them at what looked like supersonic speed.

The deadly cloud ran into an invisible wall about a hundred feet away, stopping midair and tumbling harmlessly down to leave a clearly etched curving line on the ground.

"All right!" Lola cheered, pulling away and scrabbling toward the passenger side door.

"Whoa!" Dub bellowed, grabbing hold of the back of her jacket. "Where the hell are you going?"

"To see our meteorite, of course! Come on, let's go check it out!"

Dub held tight. "No way, lady! We're sitting right here and keeping our heads down until the other one falls."

"Oh." She flashed an apologetic smile and settled back in the seat. "Sorry. I guess I got a little carried away."

Dub smiled back. "That's OK. This *is* pretty exciting."

Her eyes glowed with childlike joy. "This is like being able to get the Universe to give you a fireworks display whenever you want!"

Shortly afterward, they were on their way back home, two still-hot apple-sized meteorites in the back of the truck in a bucket. Just a couple miles from the quarry, they met a County Sheriff's Department cruiser on the road. It flashed its lights, signaling them to pull over.

"Hey, Connie," Dub said when Deputy Connie Gilmour came over to the side of the truck. "What's up?"

Gilmour peered into the cab. "Dub, that is you. And Miss Lola. What're you folks doing out this late?"

Dub realized he really didn't have a good answer. "Just out for a drive," he said lamely. "You know."

"At nearly one in the morning?"

"Sure. Less, um, traffic."

Connie Gilmour frowned, then a big grin spread across her wide freckled face. "Hey, you two weren't just up at the Quarry acting like teenagers, were you?"

Before Dub could figure out how to answer that one, Lola leaned across him and said in a low, confiding voice, "You won't tell, will you?"

The Deputy chuckled. "What the hell. A little parking ain't going to hurt nobody over legal age. Been years since Alf and I did such a thing."

"You should try it," Lola urged. "It just might make you think the stars were coming down out of the sky!"

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"With Alf? Kinda doubt that. But that reminds me. We had a couple calls saying a bright light was seen coming down out here someplace. Did you folks see anything?"

"Just falling stars," Lola assured her with a straight face.

"Hell, with Alf it would be flailing flab followed by falling asleep. I'll probably drive around a while longer, but it's probably nothing. You take folks take care."

"You bet," Dub answered. "Night now."

As Deputy Gilmour sauntered back toward he cruiser he gave Lola a look. "Falling stars?"

She patted his thigh. "It was true. And I felt the Earth move, too. The night is still young. Who knows, it might just happen again."

"Maybe, but I'm not twenty any more. Not even fifty." He put the truck back in gear and pulled out onto the road. "Which way we headed? Your place or mine?"

"Yours. So what do you think? How much do you figure we can get for your place when it goes on the market?"

He brought the truck to a screeching halt, then turned to stare at her. "What?"

"I'm figuring I can get around 150 thousand out of my place," she continued blithely. "Yours ought to bring in at least ninety thousand, and that lot across the road should bring in ten or so more. That ought to be enough for some real acreage."

As a teenager, Dub had figured out that women were going to blindside and baffle him most of his life. But hauling out this argument again seemed to come out of nowhere. "Why are you bringing this up now?"

Lola snuggled up close, beaming happily. "Because now we just *have* to move to Arizona."

He still didn't get it. "What in the world makes you say that?"

She told him.

* * *

SIX MONTHS LATER

"Now that lamp might be worth something," Lola said, speaking just loud enough for Dub to hear. "I'm pretty sure the shade is genuine Tiffany."

"Want it, hon?" he asked expansively.

"Not really. We—oh, hi, Esmie!"

Dub turned to look, saw Esmie Rogers, one of Lola's former neighbors, bearing down on them. *"Lola!"* she called. "Dub! I thought you two had moved to Arizona! You've sure got the tans for it!"

"Yeah, we moved," Dub admitted. "Got ourselves a little spread out in the middle of nowhere. Nearest town's fifty miles away, a tiny place called Scorpion Bend. Nearest neighbor is almost twenty miles away."

Esmie gave Lola a pitying look. "Whatever do you do, being so far away from everything and everybody?"

Lola grinned, her teeth very white against her tanned face. "Oh, we've got a little business to keep us occupied." She fished a card out of her shirt pocket. "It's called Meteor Right Enterprises. We find and sell meteorites. Just auctioned off a fifty-pounder to a museum for a nice big pile of money."

Esmie looked baffled. "Are there a lot of meteorites in Arizona?"

"Seem to be since we moved there," Dub answered with a straight face. He glanced up at the auctioneer. "'Scuse me. I want to bid on this."

"*I have here another box of really weird stuff*," Cork Habeeb called. "No idea what it is. Dub Urbanski bought the first one to come up. Anybody out there want to give him a run for his money? I'll start the bidding at ten dollars. Do I hear ten dollars?"

"Ten," Dub called after a suitable pause.

"I've got ten! Do I hear *twenty?*"

Lola slipped her hand into his. "Don't let anybody outbid you, David," she warned.

He gave her a sly wink. "Don't worry. I won't." ■

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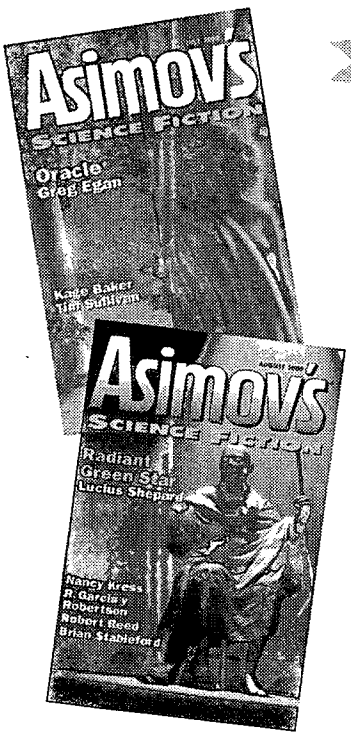

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Lost Moments

David Phalen
Illustration by Broeck Steadman

Important lessons can take a long time to learn.

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If I ever die, it will be in one of those lost moments when I'm not paying attention. Driving down a familiar road, I'll be woolgathering—thinking of the past, probably—and realize I've missed my turn. Maybe a truck will pull out in front of me so suddenly I can't react. The collision itself wouldn't kill me; but a resulting fire could do the trick.

I'm sure there's some technical medical term for these moments of internal distraction. Doctors always think they can explain things by naming them. They've done this since the time when their explanations involved spirits and demons crawling inside someone's head. I subscribe to all the top medical journals (keeping up on new health discoveries has long been a hobby of mine), but I don't always see a lot of difference between back then and today.

People who seek out neat solutions and explanations are just asking for some chaotic force to come mess them up. I've left a lot of loose threads dangling from the fabric of my life over the years, just to keep chaos from poking into my affairs. If I resist a sense of closure, I've long thought, I might live forever.

In my experience, the world is a messy place, and death is the messiest part of it. Archaeologists estimate that about four million people were spread out over the Earth when I was born, roughly twelve thousand years ago (as with medicine, I've long kept up with the latest discoveries and theories about the prehistoric past). As far as I know, all of those people are now dead, except for me. The millions that replaced them over the next few thousand years—when the population remained relatively steady—are also dead. The hundreds of millions—and finally the billions—that replaced the dead in the centuries and millennia that followed have all died as well, except for the six billion or so currently alive.

Thirty-five billion people—give or take—all of them walking through their day-to-day lives in much the way I have. Eating, drinking, falling in love, bringing still more people into the world. All of them finally—unlike me—dying. How many meals have these people eaten, how many games have they played? Who among all these billions has not felt that the kiss of a loved one was the sweetest ever felt upon lips? How many cries of pain have women issued in the pangs of labor, how many tears of joy were shed holding new babies? How many moments like these were lost forever with the people who lived them?

I usually try not to think about such things. Since the long and terrible wasting away of my mother, I have been a coward whenever faced with death.

For several years before she died, the lonely travelling that made up my mother's life after my birth was replaced by an uneasy acceptance into a tribe that viewed her as a great healer. She earned this reputation by pushing me down a rocky hill into the midst of one of the tribe's hunting parties. She hobbled down the slope after me, wailing in horror at my broken bones. With a pungent balm and some meaningless chants, she affected my rapid healing from wounds so terrible the tribe thought me already as good as dead. They held my mother in awe when I once again walked and ran and jumped as well as their own children.

Before she met my father, my mother had been bound to her tribe's medicine man, so she had a small knowledge of herbs and techniques. She knew which roots would ferment into an anesthetic she could use when she trepanned skulls to let the spirits out, but all decent medicine men in the tribes of our region—an area somewhere in southeastern Europe—knew such things. My mother's only real healing gift was her ability to project absolute competence.

That projection did little to carry her through the discomfort and uncertainty

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that were her own insidious companions in the years following my birth.

"What demon did you squirt into me with your seed?" she'd ask me during one of her sporadic menstrual flows, which always made up in intensity what they lacked in frequency. When her pain was most acute, she often spoke to me as if I were my father. "Before I let you inside of me, my blood came steady and soft as the moon. What devil twin of your son now stops me up, only to release this torrent?"

The infrequent, heavy periods were previews of agonies to come. She limped as long as I knew her (a dislocated hip had never quite healed), and the pain from that old wound crept around her body, as if demons swam through her blood with every heartbeat. Finally, there came a time when the seasons changed and the tribe prepared to move on. When they found she could no longer walk, they packed up to move without us. I tried to carry her, but the younger boys threw stones to keep us from following.

Once they were gone, I spent more and more time away from her each day, foraging for food. She seemed to shrink in my absence. She had always prided herself on being a large woman. Her physical strength and the dark line of hair growing on her upper lip signified—she claimed—that she was actually made to walk through the world with the freedom of a man. The weakness she endured as she slowly died seemed a deliberate payback for her pride. Her flesh sank in upon itself, leaving her eyes large and frightened. Her armpits, her neck, and her groin grew swollen, and she screamed in agony at the lightest touch. Some days she couldn't lift food to her own mouth; other days she could lift it but could not swallow it.

Through strange tricks of memory, I occasionally recall a glimpse of my mother as the young, strong woman she was when I was very small. More often, though, I remember her as a wasted doll of a human being, screaming out bitterly every time necessity called for me to lift her so we could move to where the berries or roots or small game was close enough that I would not have to leave her alone overnight.

When I force myself, I remember her also as the dead lump of flesh—inexplicably heavy in my arms, considering her withered state—that I placed in a small pit of a grave after she had closed her eyes for the final time. I remember the dark grimace of her features as I put beside her the bowl and pestle she used to grind roots, the stone blades she used to release spirits from the skulls of the sick.

The grasses and flowers I placed into the grave with her seemed as dried and shrivelled and useless as she had become.

How can I convey the passage of time after my mother's death? How do I describe millennia worth of steps to people who will put their own footprints onto the ground for no more than a single brief century? What can anyone say to convey the importance of all those moments—the ones lost just as much as the ones remembered—that make up a lifetime?

Wandering was—as it still is—the largest part of it. I have no clear concept of how many strides I took, how many cubits I walked, how many leagues I roamed and miles I moved through in the centuries following my mother's death. Even if I had kept accurate count of such things, it would do little to convey a sense of the distance I traveled. The world I have seen change through journal accounts and maps, surveying and satellite imagery, has grown much larger than the one I walked in those centuries. Back then, the choices I made were always small. I went a particular direction because it seemed likely to lead me to food or to shelter or to some strange experience I could play with in my mind to keep me sane during the many long periods I spent with no hu-

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man companionship.

I could describe weeks and months traveling along rivers that would not be explored for any permanent record until thousands of years after their shifting banks had washed away my tracks. I could describe the different groups of people I encountered across the centuries, and how these groups changed from families to tribes, from tribes to villages, from villages to city-states, as I left and returned. I could tell of cities I had no part in building, of wars I avoided fighting in, of civilizations that began and ended with no help from me.

In all the centuries I have wandered, I sometimes think I have learned only one thing: all human accomplishment is based, finally, on being a member of a family, an accepted part of a community.

After my mother's death, I had no family.

Until I met my father.

Like many abandoned sons, I blamed my father for all of the troubles of my youth—the beatings, the hunger, the outcast pall that hung over my mother and me and led to our nomadic existence. This blame continued well into adulthood, as I struggled to understand where I came from, why I was different from everyone else. There was nothing that went wrong in my life, it seemed, that I couldn't blame on my father.

Doctors aren't the only ones who ignore complexities in their search for easy explanations.

Before she died, my mother did little to convince me that this mental image of my father was wrong. "He was not a good man," she told me on one of the few occasions I got her to talk about him. "I *thought* he was a good man," she laughed. "I thought he was a *god*, for all the promises he made me."

"But he was a liar!" I spat on the ground to show my disgust with him. I was of an age when I would have been taking the rites of manhood, if my mother had not been exiled from her tribe at my birth. I was anxious that *she* see me as a man, even if there was no one else to recognize it.

She looked at me, then turned her head away sadly. "He was not a liar," she said. "I think a true god might have lied to me out of compassion. Your father told me only the truth, certain that I would deceive myself. What could be more evil?"

She winced and rubbed her lower back with one hand—a gesture made sharper in memory by my recent understanding of it as a symptom of the death eating away at her womb. She smiled and placed a warm hand on my cheek (my mother was always warm: another symptom, I now know).

"He told me he would live forever," she explained. "I lied to myself believing he would live forever with *me*."

When I finally met my father, he was both more and less than I had built him up to be.

He was more in his self-confidence. While I moved through the world with cautious steps, my father strode broadly from place to place, laying claim to anything that caught his eye, expecting it to be his as some sort of birthright.

He was less than I expected physically, because he was exactly like me.

I came upon my father in north-central Africa, perhaps fifteen hundred years after my mother died (though it was very difficult to keep track of years that went past before calendars were invented). I followed seasons through the migration of food sources, and I recognized patterns in the movements of the heavenly lights, though I didn't pay much attention. The study of passing time has never seemed important to me.

Back then, I traveled south during long dry seasons, up into the highlands of what was to become Egypt. I followed game that relied on the great river for its life. The river's banks had become increasingly occupied by semipermanent

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groups who saw the easy benefits in waiting for the regular flooding to ripen the grain, rather than migrating with the animals. These groups, merely a few co-operating families at first, grew into loose tribes, and gradually, into stronger alliances under single leaders who sometimes ruled large portions of either the lower regions along the river's many branches into the northern sea, or the upper regions to the south, before the land became desert.

Through the decades, I made my way from one such settlement to the next. Even when I found acceptance, I always had to move on again when those around me noticed my failure to age. Whenever I happened upon a new group, I came to expect suspicious looks from adults, laughter and taunts from children. I expected to be called names at the very least, to be chased away or beaten at worst, depending on the general feeling and well-being of the group at the time I presented myself. I travelled enough to remain familiar with the languages of the regions I passed through, becoming acutely aware of subtle nuances of inflection and vocabulary from one group to the next. In order to pass more easily, I developed a long-practiced skill and experience with dialect that allowed me to move with minimal difficulty through the region, even if I couldn't avoid the suspicious looks reserved for strangers.

But one morning I came to a village much like others in the region: a cluster of grass and reed huts like beehives rising out of the dark, silt-rich earth. The only difference between this village and hundreds of others I had passed through over the years was that men smiled at me nervously as they busily sowed seeds in the wet ground left by the receding flood. Children neither laughed at nor taunted me as they followed behind the men, playing wild games of tag, stomping the seeds into the dirt. Women stopped gossiping as I passed and looked down at their fingers, weaving through the intricacies of the coarse linen cloth in their looms. An old man tanning a hide shouted a greeting at me, calling me a name I had never heard before.

I walked toward the fanciest hut in that village—larger than the rest, rectangular. This would be the chief's hut, and I hoped to convince him to trade food in exchange for work. I hailed the hut, matching as closely as I could the dialect I had heard laughed by the children and shouted by the old man. There was a shadowy movement inside, a rustle of woven mats, then the chief came through the opening. The skin of an ibex was wrapped around his shoulders; an ivory amulet hung from his neck. His headdress held a single ostrich feather.

I noted these ornaments first, so he looked much like many other chiefs I had seen in my travels. I saw the position, not the man.

Then a child's voice shouted "Two! Two of them!" I glanced around to see children and adults making their way toward us, their faces lit with excitement as they looked back and forth from the chief to me. I gazed at him more closely, and, though I had seen myself only in reflections of muddy rivers or clear, cold mountain ponds, I made out the resemblance.

"Gods!" said my father, a wide grin blooming on his face. "One of them lived long enough to give birth."

In my years of wandering, I have seen fathers who beat their sons repeatedly, and fathers restricted by taboo from laying on so much as a finger in anger. I have seen husbands kill wives by putting them through repeated childbirth in an effort for a son, and I have seen men much more content with having daughters who posed no threats to them. I have seen strict fathers and lax fathers, loving and tyrannical fathers, fathers who ignore their sons and fathers who dote on them far too much. The observance of fathers is an obsession of mine even larger than archaeology and

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medicine.

In twelve thousand years of watching fathers interact with sons, though, I have never seen another father like mine.

I suppose every son would say the same.

"You're from across the great sea, then?" my father asked me. He sat on a low stool outside of his hut, while I kneeled on the ground before him to answer his many questions. People still milled about, finding reasons to come close enough to overhear bits of what we said to each other.

"I have traveled much," I told him.

"And what was her name again?" he asked for the twentieth time. When I told him, he shook his head. "Perhaps I remember her. A very large woman, you say?"

"She took great pride in her size," I said. The ground beneath my knees had grown uncomfortably damp from my sweat. Even after so much time, I didn't like to talk about my mother.

My father spat on the ground not far from me, an act of contemplation, not contempt. "Gods! There have been so many that they all share the same face." He looked at me and grinned. "I don't have to tell you what *that's* like."

I nodded—though, in fact, I had known very few women in the way he meant. I had never had much of a sex drive; and on most occasions when such impulses came upon me, I was alone in some wilderness. Since my mother's death, women had played no significant part in my life.

The smile still on his face, my father's eyes narrowed. "And how many seasons since your birth?"

The reluctance to admit the length of my life was so ingrained that I hesitated, even though I knew he must share the same secret. "I had no tribe to trace my birth, but I have lived many seasons," I answered as safely as I could.

My father laughed. He stood up, towering over me as I knelt. "Come," he said. "We will walk."

We walked out of the collection of huts, past the watching eyes of men and women and children who wondered what type of omen I was. If they wanted to follow, they must have seen something in my father's manner that discouraged them. We moved alone up grassy, sloping ground away from the river, toward a crest of the hill broken by jutting rocks. "You walk like someone who has spent many lifetimes walking," my father commented.

"I have walked," I admitted.

"When I was younger. . . ." He smiled as if this phrasing greatly amused him. "When I was younger, I walked to the four ends of the world, just because I knew I could do it."

I looked behind us at the receding huts. The tall grass thinned the farther we went, giving way to rockier, sandier soil as we moved into the hills. "I walk to find food," I said. "To find shelter."

He laughed. "Goals too small for a son of mine." He stopped walking and pointed back toward the village. "*They* find my food. *They* build my shelter."

I looked away. "Their sons will chase you away when they realize what you are."

He laughed, loud and booming in the clear, bright afternoon.

"These are the *grandsons* of those I first led. I am their god."

"We are no gods," I said softly.

He began walking again, up a short hill toward a yellow bluff. I followed. "We are gods," he assured me.

"People do not want a god who walks among them," I said. "They will chase you away."

"People *crave* a god who walks among them," he said. "Men want to die gloriously for me. Women want to open their loins and bear my sons."

"I do not know such men and women."

He laughed again, a thunderous sound that echoed off the hills and rocks around us. It frightened me. I looked into

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his face and saw myself. But I had never laughed like that, had never thought the thoughts this man was thinking. It was as if I was watching myself possessed by a demon. I had to turn away.

His laughter went on for far too long, as I looked down the slope of the hill where we stood. The village was small next to the river, and the movement of its people seemed smaller still. Even after his booming laughter finally died down, I could still hear my father chuckling to himself.

"You are something new at last," he said, surprising me by whispering it into my ear. "I don't know how long you have been around, but I can see in your eyes that you understand. You have begun to fear the days ahead, when all things will be old things, and there will be nothing new anymore under sun or moon."

"It is a long life," I said, keeping my eyes on the river, not daring to look over at him for fear of seeing myself again. "It is an old world."

"We can make it new again," he said. He held his arm out to indicate the village below us. "They will do what I demand. Others like them are waiting for us, even if they don't know it yet. The river brings them life; I give them meaning."

"We are simply men."

"We are *not* men," he insisted. "We are such beings as men wish to follow. I can unite these tribes, unite this entire land. They will build monuments to us."

I turned to look at him, gazing at the river. "What would they build?" I asked him. "What can they make that we will not see turn to dust?"

The question surprised him, and he shot me the angry, defiant look of someone not used to being challenged. "They will make such monuments as I tell them. They will make relics unto me that the ages cannot diminish."

He stood there, slightly above me on the slope, his eyes fixed into the distance of a future that need never end for him. He looked so confident, so full of his own importance, that I wanted to hit him. To hug him. My father.

"Why did you leave her?" I asked bitterly. "Why did you leave *me?*"

He shook his head. "I don't remember her. She could have been any one of a thousand women. I left her for the same reason I always left them. She was dying."

"She was not dying," I said. Then, realizing what he probably meant, I added, "She did not die until I was nearly grown."

His eyes widened in surprise. He shook his head. "You are lying," he said softly. We stood silently for a time before he continued. "Your mother—whoever she was—was not the first woman to spread her legs for me, to lust after promises of eternity. You think I have not longed for a son? You think I have not wanted another in the world who understands what it is to wake up every day while those around me fall asleep forever? I have spent hundreds of seasons—thousands—convincing women to lie with me, to let me put myself inside of them."

I turned away from him, my face hot with a passion I had not felt in many years. "It was a game you grew bored with."

He put his hand roughly on my shoulder and turned me around to face him. "It is a game I play at still, but that is not what I mean. They *died*. They *all* died. There were no sons. There were no babes at all. As soon as my life quickened within them, the women became ill. None lived long enough to give birth. After so much failure, I could no longer place the fault upon them. I knew that my life inside them was poison."

I thought of my mother, of the strong woman she was in my earliest memories, of the wasted doll she later became.

"Until I saw you today," my father continued, "I thought *I* was to blame. But it was *them*. They were too weak to carry my seed. To bring the son of a god into

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the world. Clearly, your mother was not weak."

I looked at him, at the man who had occupied such a large portion of my thoughts for so many years. At the man who was just like me. The man who would be a god. I had to turn away.

"And now you have a son," I said.

"And now I find I am a jealous god," he said softly behind me. Then he struck me so hard in the back of my head, that I lost many, many of the moments that followed.

The Greek princess Alcestis offered her life in the stead of her husband, Admetis, but was later rescued from the underworld by Herakles.

The Corinthian king Sisyphus convinced his wife to leave his body unburied, which so upset Hades that he asked Sisyphus to return to Earth to set things right. Upon resuming his body, Sisyphus defied orders to return to the underworld, and picked up his life where he had left off.

In the Christian Bible, Jesus rolled a stone from a tomb and Lazarus—dead for three days—walked forth. This foreshadowed Jesus's own resurrection later in the same story.

Such resurrection occurs in hundreds of legends like these from nearly every world myth.

None of them mentions how painful it is to rise from the dead.

I don't know how many moments I lost under the hastily piled stones my father used to bury me. Those whom doctors have revived from the kind of "clinical" deaths that seem so common these days often report visions of themselves floating toward a beautiful light, a place they feel will answer all questions, all prayers. No such place revealed itself to me.

When I awoke, the stones on my chest pressed so tightly that I could barely breathe. The ground at my back was wet and sticky from my blood. I moved my right arm, and the rocks settled more tightly around me, pushing against my face. I moved my left arm and the rocks shifted again, loosening above me ever so slightly. I tried my left leg, surprised and dismayed—in the hazy way that was all my mind would allow through the pain I felt—that its movement came at an impossible angle from where it should have been. I moved my right leg, and the pile shifted again. The sharp edge of a stone dug painfully into what felt like exposed hip bone.

I do not know how many hours—how many days?—passed in this play of subtle movement and experimentation. Whenever the pain grew too intense, my mind would simply shut down. Every time I awoke, my body had succeeded a bit more in repairing the damage wrought by my father.

At last, my arms came loose enough to start working in earnest at the rocks. I moved enough of the pile off to pull myself free. I scrabbled on my back to a place shaded by a large boulder a few feet from my grave.

I waited in the shade until night fell. Beneath the crust of blood and dirt that covered my arms and legs and chest, my skin pulled taut over bones that ached as they seemed to melt in their brokenness and reshape themselves. My body knitted itself back together with an itching tickle that kept me awake. My stomach screamed for food; my throat burned for water. A brief rain shower fell hard and fast on my second morning free of the stones. The cells of my flesh were like sponges soaking in the liquid nourishment. Near dusk on my fourth evening free, I made a short, painful walk away from the direction of the river on twisted but healing legs. I collapsed in a gully beneath a bush whose hard, bitter berries and sharp, waxy leaves I ate hungrily.

The clearest thought in my mind that day and in the days that followed—after fear of my father's pursuit finally abated—was a promise to myself never to have a son of my own. It was a promise

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managed to keep for nearly five thousand years.

Who of those who would condemn me for breaking it has ever kept a vow for so long?

In those five thousand years, my father fulfilled his own promise to make the world new again, though I never saw any of it firsthand. I walked north, following the banks of the sea into what would later be called Europe, where I continued my trek over land and ocean. Sometimes I traveled into the colder climates. Several times I made my way east as far as the Pacific Ocean. But it was many years before I went south again. From occasional travelers over the centuries (but mostly through archaeology texts I read much later), I learned of my father's influence in creating the country and the culture that eventually built the huge monuments to him that he thought he deserved. Those monuments still exist, though he, presumably, is now gone.

For a couple of thousand years, travelers that came north from Egypt told of a society grown larger and more advanced than any the world had ever seen. This society, according to traveler legend, was ruled by an immortal god-king, generous in his munificence, but capricious in his whims. The legends I heard were fragmentary, full of hearsay, but after a while, it became clear to me that this god-king had somehow disappeared. Whether he was deposed from his throne or simply wandered off, I still do not know. It may be that his people made of him the first mummy, removing internal organs and wrapping him in an effort to kill him at last. Remembering my own "death," I liked to think that they buried him under tons of rock in some great pyramid. Perhaps such a burial has kept him deader than it kept me.

As my fear of his influence waned, my travels gradually took me further south, where for a number of years I settled into various cities and communities in Greece (Herodotus's account of Egypt was the final assurance I needed that my father no longer ruled there; my father would have made himself the hero of the account had he known about it). The towns and villages I lived in swelled with people as agriculture refined itself. The rise of true architecture made living conditions more comfortable. The leisure time for philosophical thinking made conversations more interesting. For the first time in my life, I found myself surrounded by people for long periods of time.

It was a very short step to falling in love.

She was dark-haired and large, like my mother. Her eyes were the luminous blue-gray of an ocean sky. She was strong and confident and so full of life that every young man in the village where I lived—only a day's journey from Athens, the center of the western world by that point—must have been at least a little bit in love with her.

For some reason, it was me she loved in return.

I will not write her name here, because it is a name I have not spoken in over 2500 years, since my son was a small boy.

I will not describe our meeting and our courtship, because to describe these moments would make them some kind of common experience you would think we could share.

I will give no account of the brief days of our marriage, make no attempt to recreate my feelings of hope and dread when life quickened within her.

I will not tell you all the gruesome and heroic details of how she wasted away even while growing large with child, of how she struggled to bring the baby to term, then begged me to cut her open and remove it from her womb when she knew she had reached her final day before deliverance.

These moments have been mine and mine alone for far longer than you have been alive. If I ever disappear from the

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world and they are lost, then perhaps that is as it should be.

Raising my son, I vowed to be as different from my father as I could. I answered all my son's questions about who he was and where he came from. I talked to him and taught him. Most important, I was at his side to listen to him and learn from him as he grew to look just like me and we spent many years together moving through the world.

My interest in medical things came from my son. Though I tried to explain to him that doctors had nothing to offer us, still he followed them around, seeking out the wisest and most effective healers wherever we found ourselves. Most often—especially at first—they grew frustrated with him, since he was never content with finding out what medicines they used, what procedures they performed. He always probed further.

"Why do you do it that way?" he inevitably asked. "How does the medicine affect the body to lead to this cure? What function does the procedure serve that the body is not taking care of for some reason?"

Through centuries of travel, he spread his curiosity, never content with a "what" when there should be a "why" somewhere beyond it. For years, I think now, he was a Johnny Appleseed, sprinkling the seeds of inquiry on the fertile ground of human intellectual development. I watched him turn men and women from little more than superstitious drones, going through motions that had been established generations before them, into questioning, thinking "scientists."

Content to wander through the world and let life and events happen to me, for centuries I watched with pride as my son—inheritor of no such contentment—tried to find the connections that would explain to him why he was like he was.

And why we were different from everyone else.

The most painful lesson I have learned in a long life filled with painful lessons is that it's far more natural for children and their parents to break away from each other than to stay together forever. Especially when forever is such a long time.

My son's break from me was less dramatic than my father's. As the Roman Empire and all its learning fell with increasing rapidity under the dogma of Christianity, my son insisted that we make our way to the east, where the rising Arab-speaking countries were much more tolerant of nondoctrinal theories—including theories of medicine—than their Christian counterparts. It is far easier for me to trace our movement in these historic times than in the millennia that preceded them, if only by the names of the people my son worked with: Aëtios, Paul of Aegina, Alexander of Tralles.

It is easy for me to see now that even in the centuries we spent together, my son was drifting away from me. We traveled with one another to the places and people my son wanted to see, but even that traveling was separate. I took care of the quietly familiar duties of the household while my son spent his days seeking out that which was not familiar. I made sure we had places to live. My son made sure he met with every healer in the area. I spent my days finding food to put on our table, preparing that food in the familiar ways I knew my son enjoyed. My son spent his days exploring new theories and discoveries, holding the greatest minds of whatever time and place we found ourselves to a standard that never stopped asking questions and exploring alternatives. I kept track of the reactions of the friends and neighbors surrounding us, long experienced at knowing exactly when a niggling doubt became a true suspicion, something to be feared. My son remained mostly oblivious to the reactions of anyone, deferring to my judgement with increasing reluctance as the places we found ourselves held greater

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and greater promise of answers for him.

There is little point in tracing our lives in those days, except to say that the most important moment—the last moment when I felt I belonged to something greater than myself, to a family—came in Jundisapur. We were at our table, eating a modest meal of bread and fruit. My son had spent his day at the city's large medical center, caring for the sick and the dying, of course, but mostly trying to understand why there was such a thing as sickness and death at all.

"I sometimes feel that the gods have made me stupid on purpose," he said to me.

"You simply ask questions that can only be answered by the gods themselves." I sucked on the sweet pulp of a date, my tongue playing with a corner of its stony pit.

Though the plate in front of him was full of food, he did little more than move it around. "If a man can conceive a question, he should be able to divine its answer."

I spit out the date seed and picked up some bread from my own plate. This was a conversation we had had many times before, so I wasn't paying much attention to what either of us was saying. "Perhaps there are questions that can only be answered in a lifetime beyond this one. Perhaps the Christians are right and there is one God who answers all eventually." I bit into the bread, chewing its heavy roughness with teeth as strong as they had been over ten thousand years earlier.

"We *have* no other life than this," my son said bitterly. "*We* have nowhere else to hope for answers."

"Then perhaps we should stop asking questions," I said. I meant it as a joke, nothing more. I was honestly paying more attention to the wine I was drinking than I was to him. If the silence of that moment went on any longer than was customary between us, I did not notice.

"It is time for me to leave," he said to break that silence.

I looked up at him then, though the statement did not strike me as overly strange. We had been in the city long enough for me to notice the gray creeping into the hair of those few acquaintances close enough to call us friends. But something in his voice put a sharp bit of dread into my stomach.

"I can begin making arrangements," I said. We had very few material possessions, but moving always required a period of time when we could convert what we did have into some form of currency that was safe to travel with.

My son shook his head. "I think it is time for me to find my own place in the world."

"Your place is with me," I said. I tried to put some force behind it, but it had been centuries since I had felt real anger. I was out of practice.

He looked away from me. "There are answers. I need to look harder for them."

I understood how it was then, and for a moment real anger almost bubbled up from within some long-forgotten appendix inside of me. He had joked of my complacency, my willingness to let the world go by with absolutely no desire to understand it or reshape it. I realized in that moment, across the table from him, that his view of me was no longer a joke.

Before the anger could boil over, though, something inside me—something that must be a part of the makeup of who I am—removed it from the flame. It settled deep into the pit of my stomach, no longer real anger at all. Simply bitterness.

Meeting my son's gaze across that table was like looking at my own face. As painful to admit as it was, I understood that when he looked at me he did not see himself.

I made the arrangements for us to move as usual. When the actual moment came, though, I split what we had. We travelled in separate directions.

It was many years before I spoke with

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my son again. Even after time had salved my injured pride enough so that I no longer desired to rebuff any overtures he made, I never sought to establish contact myself. For the first five hundred years we were apart, I heard nothing of him. After I accidentally ran across him in Salerno, he began making an effort to find me once every century or so.

Our meetings were short—two or three weeks, generally—though there was no reason they had to be. He would talk with much frustration of the slow progress he had made in his understanding of who and what we were. In Brussels during the late 16th Christian century, he spoke excitedly about his work with Ambroise Paré and the way the simple dressing of wounds seemed more effective than the boiling oil cauterizations usually performed on battlefields.

"The body wants to heal itself," he said to me. "What mechanism switches that desire off at death?"

But in 18th-century Glasgow, his frustrations had returned. "We're cataloging what we know, but everyone is afraid to learn something new."

Of my own travels, I told him little; and he did little to pretend he was interested enough to pry.

The years went by us. Life went by us. Death went by us. With the rise of medical journals in the 19th century, I started paying my own kind of quiet attention to what was happening. Still, I was surprised when he showed up at my door in the late 1970s, as excited as I'd seen him since he was young enough to still look slightly different than I did.

"Endometrial cancer!" he said, even before I had let him into my apartment.

"Would you like to come in?" I asked him. "I have beer in the refrigerator."

After we had settled into my living room, he told me what he had figured out.

"Endometrial cancer is a form of the condition that appears in the uterus of maybe two or three percent of all women," he explained. "Occurrences in younger women are infrequent, and almost always tied to symptons of excessive androgens: no menstrual periods and the development of normally masculine secondary sex characteristics—facial hair, deep voice, abnormal muscle mass."

"And you're telling me this for some reason?" I said.

"Your mother," he said. "My mother. All the women your father bragged about."

I looked at him. Even though he was many centuries older than anyone else I knew, I still saw him as the small boy he had been so long ago. "But endometrial cancer usually occurs after menopause," I pointed out.

That stopped him for a second. "You've been doing some reading," he said.

I shrugged. "A hobby, nothing more."

He smiled wide. At that moment I don't think I would have traded back all the years of loneliness and bitterness if it meant I also had to give back the new respect I saw in his eyes.

"The fact that they were premenopausal might be a clue," he said. "If the diagnosis is correct, it's hard to statistically account for the condition in this many young women. Especially if we assume they developed the condition when they became pregnant."

"Is that possible?" I asked him. I had pretty much exhausted my knowledge on the subject.

He shook his head. "It shouldn't be. When the hGC kicks in, levels of progesterone should be more than high enough to balance out any level of estrogen. I suppose there might be a minute chance that the condition may have been pre-existing, but again, statistics make it seem doubtful for so many women."

The medical terms were familiar as little more than names I had seen before, but I thought I saw where he was going. "So you think he was right. His seed really was poisoned?"

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"As is yours. And mine."

I took a drink of my beer. "You think we're clones?" In past meetings, new terminology had been one of the chief obstacles to conversations like this, but I now had more resources available.

Again, I caught the slight smile of pride. "It certainly seems likely."

"But is it possible?" I asked.

He took a drink of his beer, thinking about how he would answer. "Not in any natural way that I can think of. There's some speculation that in very rare cases a human egg might actually split itself into a zygote of matched chromosomes without the aid of sperm."

I smiled. "An immaculate conception?"

He shrugged. "I'm doubtful myself. But even if it did happen, you'd get a clone of the mother."

"Which doesn't explain a clone of the father."

He laughed. "No, it doesn't."

"It's good to see you again," I told him.

He stayed with me for nearly a month that time, my "twin brother" from the United States. We spoke of the new types of cellular research that were unlocking the mysteries he had spent so many centuries trying to unravel. We talked of what we now knew of the secrets of DNA, of the combining of genes into the chains that make us who we are. I was clearly the novice in these discussions, my son clearly the expert; but he appreciated having an informed mind to bounce his theories off of, someone with a shared history of experience he couldn't find anywhere else in the world.

"It's going to happen," he said to me on the night before he returned to his own home, to the work he was doing. He had left vague hints that I might come with him, but I had left clear indications in return that I wouldn't. "In the next twenty or thirty years, we're going to figure it out. The technology is nearly in place."

"I told you you were smart enough," I said, returning, if only obliquely, to the relationship we had shared for so many centuries. "You just needed the patience to let the world do a little of the work for you."

In the past twenty years, humanity has learned more about disease and aging and dying than I learned in all the centuries and the millennia I have lived. I know now how cells grow and some of the many ways in which they deteriorate. I know something of how genes work their magic on individual cells to allow them to perform the functions for which they evolved. I know how enzymes work on DNA to affect the ways it combines and recombines into the many forms that make up life.

I also know, through the work of my son, why I am still alive when everyone else dies.

And I know at least one certain way to change this condition.

In the years after his insight about my mother's cancer, my son kept in touch. Phone calls became an easy, if infrequent, means for him to keep me posted on the progress he was making. In the mid-1980s, I moved to Canada, where I currently live, and he made an effort to visit me at least once a year, even though I returned the effort only once.

It is that visit which haunts me most about my son's death. The clues to what would eventually happen were all around me, but I simply ignored them. At the time of my visit, my son lived in a small, sparsely furnished house he rented in the country a few miles from the college town where he worked as a graduate research assistant in a molecular biology lab. That house was telling me secrets of the future, if I had only listened.

"Graduate students ask all the important questions," my son said when I teased him about not being a full professor. "Plus they get the fun of actually doing the work that finds the answers."

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He introduced me as his wandering, n'er-do-well twin brother. He showed me his lab and talked about his work in terms which my educated-laymen's understanding of the field could barely keep up with.

"Right now we're working with telomerase, an enzyme from reproductive cells," he told me. "It seems to bind the telomeres in chromosomes so that they stop shortening with each cell division. If telomeres didn't shorten, theoretically, nothing would keep cells from dividing and recombining indefinitely."

"Meaning that the organism made up of those cells might live an exceptionally long time," I said.

"If it pans out," he said in the understated way of someone trying not to jinx things. I let it go at that, not wanting to push him into areas where he felt uncomfortable, just like I later let go of our discussion of how the book collection in his home seemed to be split between titles dealing with medical and cellular research and titles dealing with religion.

"You looking for God as well as for DNA?" I joked one evening during my visit.

He laughed. "I'm not sure there's a difference."

"God has better PR," I said. "Unless my father really was God, in which case he had a lot to learn about dealing with the public."

My son smiled, but I could tell if I kept my mouth shut, he would probably say more. I kept my mouth shut.

"The deeper I work with genes," he finally said. "the more I tend to personify what they do. In a lot of ways, DNA seems like the ultimate survival organism. It found ways to reproduce itself in single-celled creatures, then managed to evolve from there into a mechanism that split its chromosomes in two and reproduced by combining traits in billions of combinations, just to find those few that worked the best at getting it to the next combination. Sometimes I wonder what new method it's going to come up with a million or a hundred million or a billion years from now, when the possibilities of two-strand combinations have been exhausted."

I knew I was out of my depth, so I kept quiet.

"The problem is, thinking that you're just a temporary permutation used by a string of proteins to explore the possibilities of life is pretty depressing. Especially in our case."

I couldn't let that pass. "Why especially in our case?"

He shot me a curious look, as if it had never occurred to him that I wasn't following the same reasoning he was in his private thoughts. "When it comes to exploring life's possibilities, we're a dead-end," he said.

"Living forever is a dead-end to exploring life?"

He shrugged. "It is if you can't reproduce something new."

"How do you figure?"

He sighed, preparing himself for something he obviously wanted to talk about, but didn't really want to think about any more than he had to. "One branch of current cloning research has discovered a way to wipe the genetic material out of an egg, leaving its shell basically intact. Eventually—soon, probably—we should be able to take the full genetic material out of a completely separate cell, insert it into this egg shell, and find a means to force it to begin splitting. This will give a full clone of whatever organism donated the genetic material. The egg itself will simply be packaging that is discarded."

"What does that have to do with us?"

"One possibility for how we came into existence—both of us essentially clones of our fathers—is that our own genetic material, the DNA in our sperm cells, contains some type of enzyme which reproduces this egg-cleansing process naturally. When sperm meets egg, instead of one strand from each combining, sperm DNA in some way devours egg DNA and leaves the two strands of its

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host in place of freshly combined strands."

I became excited at hearing the first real answer to who I was in over twelve thousand years. "You've known this and you're only now telling me?"

"It's a *theory*," he qualified. "One I can't test unless I can get my hands on some egg cells."

Of course, I knew he could test it without laboratory eggs: in the same way I had inadvertently tested it on his mother. The way my father had tested it on who knows how many women over the centuries when he was living as a god.

In other words, my son could test his theory in a way that was completely unacceptable to who he was.

"Anyway, it fits the data and the known possibilities," he said. "Especially if the hGC hormone is wiped out in the process of wiping out all the other female characteristics. Estrogen levels would be abnormally high, with no corresponding rise in progesterone, making the woman a prime candidate for endometrial cancer."

I thought of my mother and the years of pain she endured. I thought of my wife for as far as I could let myself go down that path.

"Regardless of how it happens, though," my son went on, "from a 'DNA is God' standpoint, clones completely end the creative process. They are genetic material making copies of itself, with no new permutations even possible. A dead-end."

He fell silent, and that's where I let it end. Only now, after his death, do I wish I'd made him talk it out further.

Though it probably wouldn't have done any good.

As painful as the deaths of my mother and my wife were, they in no way prepared me for losing my son. I always expected to lose the two of them. Like me, though, my son was supposed to live forever.

I didn't become aware that he was dying until the last time he came to visit me. Our phone conversations had been perfectly normal: he expounding theories that were coming ever closer to figuring out how our bodies do what they do, me serving as the attentive sounding board.

"I've got it," he said finally, almost anticlimactically at the beginning of one call. He sounded satisfied, but not necessarily happy. Considering the length of his search, this struck me as an appropriately dignified reaction.

"It's telomerase," he said. "When the cells age and divide in normal people, the telomeres grow gradually shorter. After a maximum of maybe 90 divisions, the telomeres can no longer hold the chromosomes together during the split, so they simply stop dividing. *Our* cells—yours and mine—are set up in a way that allows them to produce new telomerase, which actually repairs telomere damage after cell division. As far as I can tell, our cells could continue dividing and repairing themselves forever."

"Congratulations," I said. Thousands of lifetimes worth of questions answered, and I could think of nothing more encouraging to tell him.

"That certainly solves that mystery," he said. Then we found we had little more to talk about.

When he came to visit a few months later, I barely recognized him.

He was still me, in a sense, but a worn and beaten-down me. Most of his hair was gone. His skin was shrivelled and dry. He walked with a stoop, like a man in pain.

"What have you done?" I asked him. "What have you done?"

What he had done was find a way to alter the cellular process. Telomerase is simply an enzyme that performs a function: helping cells to divide. Enzymes can be altered.

"At first," he told me, "I tried to work out a way to introduce another enzyme that would block the telomerase, keep it

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from rejuvenating the telomeres and allowing the chromosomes to continue indefinitely. Gradually growing old has always held a romantic appeal to me."

"This is not gradual," I said. He was lying in my bed, struggling to breathe. He had not eaten since his arrival. He could barely keep down water.

"No," he said. "*You're* the true romantic of the family. I must have inherited something of the practical from Grampa."

He coughed, and I reached out to hold him, but finally pulled my hands away. What could I do for him?

"There was an easier way to get where I wanted to go."

"Cancer," I said simply, and he nodded, too worn out to continue. He didn't need to.

While I don't know as much about the enzymes involved in cellular biology as my son, I do know this: an abundance of telomerase in a cell causes it to divide out of control, reproducing itself from the less specific coding of its RNA. Cells grow at an ever-increasing rate, without regard to the specific function they are actually supposed to perform within an organism.

In short, telomerase causes cancer.

Like the cancer that spread through my son so rapidly that he was dead within a week of arriving at my home.

In that week, my son taught me more about being human than I had learned in all of my very long life.

"Did I ever tell you I worked with Flinders Petrie at Abydos?" he said one evening as he sat in a chair next to the bedroom window while I changed the bedsheets.

I paused and looked over at him. "You went to Egypt?"

He smiled at me, a sunken grimace that made me want to wince whenever I saw it. "Every once in a while, I've gotten burned out on medicine. Two thousand years without a career change will do that to you."

I went back to making the bed, mostly so I wouldn't have to keep looking at his frail body, at the effort he had to expend just to keep his head held up. "So you dabbled in archaeology?"

He coughed/wheezed, a sound so alarming I looked quickly back over at him. I realized he was chuckling. When he caught his breath, he said, "If a ten-year apprenticeship as an assistant to Schliemann was dabbling, then I was a dabbler."

I looked away again, suddenly very interested in making sure the new sheets were put on the bed just right. "You went to Greece too, then."

"Sometimes, over the years, I've just felt like I wanted to go home again."

I briskly unfolded a blanket, snapping it sharply in the still air of the room. "We left Greece when you were still an infant," my voice was as sharp as the snap of the blanket. "It was never your home."

The room was silent for a few moments, with only the soft noises I made stuffing corners of blankets under the mattress and putting pillows in their cases. Then my son spoke quietly again, "Haven't you ever really thought about where you came from? About what everything in life means?"

I looked over at him: he was me as the old man I would never become. I sat on the edge of the bed. "Why did you go to Egypt?"

He shrugged, smiling slightly again. "I think I half-expected to find Grampa. To pry a stone from some hidden passage and watch him come screaming out, roaring at the world."

I smiled at the image. "What *did* you find?"

He looked out the window at the dimming light. "One afternoon, when we were taking a break from work until after the heat of the day, I walked up a hill away from camp and looked back down, at the tents and the river flowing behind them. There was a village not far away, and I could see children running around,

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playing. When the wind was just right, I could hear them laughing. I thought of you, standing on a hill like that with your father." He paused, looked back at me, and smiled. "The hair on the back of my neck stood up. I almost ducked, thinking someone must be sneaking up on me with a rock."

I rose from the bed and held my hand out to help him up. He took it and stood. When I had him back under his covers and as comfortable as I could make him, he continued to hold my hand.

"I found the same thing you found on that hill," he said. "I found that we are not gods."

On the night he died, the need my son felt most was to explain himself to me.

"You haven't asked me why I've done this," he said, his voice so soft I had to lean forward over the bed to hear him. I'd made a half-hearted suggestion that I could take him to a hospital, but he'd laughed so hard I thought he was going to shake himself apart.

I shrugged. "It's an old world. It's a long life."

He shook his head. "I think I've wasted over half my life just being furious with you," he said.

I leaned back. I had to struggle to catch my breath. "With *me?*"

He smiled, his eyes closed. "Sure with you. You're my father, aren't you?"

I slumped forward. "I tried to be a good father."

Eyes still closed, he reached out his hand until I took it in mine. "You were an excellent father," he said. "It's just that you couldn't answer any of my questions."

He smiled, and I squeezed his hand. "You answered them for yourself," I said. "I'm very proud of you."

He took a deep breath, then lay still so long I thought it might have been his last. I reached over to check, but he spoke again. "I answered the what," he said softly. I had to lean so close to hear him that I could feel his breath on my ear. "If there's an answer to why, it's in another life than this one."

I sat with him that night, listening from moment to moment to his shallow irregular breath, until finally it stopped altogether.

I buried him, like I buried my mother and my wife. And I've gone on, like I've gone on after the deaths of 35 billion people, most of whom I've never known, but all of whom had just as much call for a mourner as my own boy. I think now of the moments I spent with him, and I carry on with my own life, which I now know I can end if I so desire.

But I'm not my son. I have no thoughts on whether there might be another level after death that can provide more answers. If I am a genetic dead-end in a universe created for DNA, then so be it. I'll try to make the most of each of the many moments in my dead-end life, as I have always done.

Only now, after putting it off for so long, I will give myself permission to perform the most human act I can imagine, an act I have felt I could deny myself by virtue of the accident of my own eternal life.

Now, I will mourn for all those who must die.

I'll mourn my mother, who fought her own cells long enough to give me life and make sure I was grown.

I'll mourn my wife, whom I killed with my love, but who, dying, gave me the greatest gift of my long, long life.

I'll even mourn my father, who may be alive out there somewhere, perhaps still buried under a long-forgotten temple he ordered built for his glory. Or who may be ashes blown in the wind like so many others over the centuries.

But mostly, I'll mourn my son, who has taught me where I came from and who I am. Who has taught me, at last, that any life, no matter how short or how long, is diminished by the moments we allow ourselves to lose. ■

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Rajnar Vajra

Illustration by Kelly Freas

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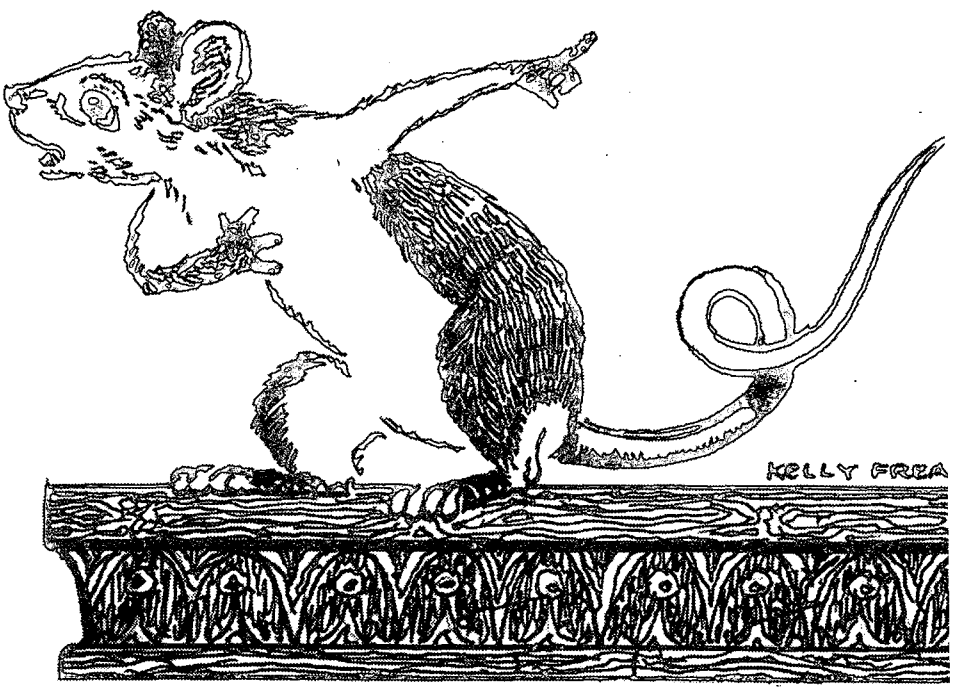
Politics can make even stranger bedfellows than you've ever imagined. . . .

Standing Firm on the Pipette Line



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I'll tell you what lurks in the shallows of *my* memory. Fearful Friday. I'm talking about October 29, 2021, the eeriest day of my life. And my God, the way it ended! Let's put it this way: a hungry shark in my Jacuzzi would be easier for me to forget about than Fearful Friday. Two years and two months have slipped by since that horribly premature Halloween, but I can still remember every grotesque detail. Hell, if I close my eyes and let my mind drift, I can practically taste that morning's coffee. . . .

My breakfast nook, gilded by sunrise, was glowing cheerfully. Friday had always been my favorite day of the week and this one promised to be clear and crisp. But instead of savoring my beloved Jamaican Blue Mountain as usual, I was feeling it etch away at my stomach lining like concentrated sulfuric acid. I sipped and winced, dreading the upcoming afternoon press conference. The only bright spot, I decided in my vast innocence, was that I'd surely reached the penthouse level in my personal tower of stress.

But even the press conference exceeded my worst expectations. By 2:05 PM, despite fifteen minutes of my smoothest dodging and sidestepping, the truculent sea of reporters had sucked me into a maelstrom of awkward questions. Under my Armani jacket I was sweating like a cold pipe in a steam bath.

Don't get me wrong. Like most politicians, I adore media attention, but not when I'm in a jam. Especially such thick jam and such extravagant attention. Enough microphones were stuck in front of my chubby little face to record the Boston Symphony twenty times over. And, worse, no less than fifty live-feed video cameras were aimed my way, poised to capture every little slip-up, stray drop of spit, and facial twitch. If I appeared even fractionally confident, I deserved a damned Academy Award.

So many extra reporters had showed up, we'd had to set up outdoors. And out in the open, standing on New City Hall's concrete steps, the smell of rotting garbage kept adding insult to insult.

"Why are the Minuscules striking, Mr. Mayor?"

"As I already stated, we're looking into that."

"Why is this only happening in Boston, Mr. Mayor? Why not New York or Seattle?"

"We haven't yet come to a definite conclusion on that subject."

"Is your *ship* sinking, sir? Maybe this is more a desertion than a strike." The witticism drew a good laugh, but not from me.

"Mr. Mayor! Mr. Mayor! What are you planning on doing about . . . ?"

My press secretary, Dr. Lisa Stockton, knew I'd had enough and smoothly pulled me out of the line of fire to take my place. Lisa is wonderful. She knows exactly when and how to be a squid. I stared up at the attractive back of her head wondering what color ink she was going to squirt out *this* time . . .

"Thank you for your solicitude, ladies and gentlemen," she announced in her crispest professional voice. "But now Mayor Gould needs to return to work so that he can continue the fine job he's doing of managing this unique crisis."

If she noticed the sound of a thousand simultaneous grumbles, she didn't show it. "I believe our Mayor has already addressed most of your concerns. We will certainly have more to tell you later, but I'm sure we all agree that the time has come for deeds, not words."

I couldn't detect any signs of such agreement, but I nodded and smiled as if every soul who caught my eye was the one exception to a universal rule.

Then it took my entire security staff, fifteen burly weight lifters, to get me through the crowd that rushed the steps, lenses and hand-held mikes held out like thrusting swords, and the whole time I kept thinking, *deeds?* What in hell

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am I supposed to *do?* For three weeks now, I'd been waiting by the red telephone—the so-called "Pipette Line"—bracing myself for some tough negotiations. But how do you negotiate with striking workers who never bother presenting any demands?

I was nearly within smudging distance of the door to New City Hall when an unfamiliar reporter snatched me from a fog of worry by somehow reaching past my guardians and grabbing my sleeve. He was shouldered back by at least three security people.

Let's get one thing straight: you can't believe everything you may have read or heard about me; the media loves caricature far more than character. And yes, I know about those jokes that keep percolating throughout New England: What's the fastest way to commit suicide? Answer: stand between Tully Gould and political office. What's the tallest mountain in Massachusetts? Answer: Mayor Gould's ego.

Terribly amusing and perhaps there's even a few quarks of truth hiding in there somewhere. But while I'm no Saint Francis, my first reaction when the reporter went down hard was honest concern for the man's safety and worry that he'd been hurt.

"Pick him *up*, damn it!" I urged Little Jerry Connelly, the guard closest to our victim. "He'll get trampled in this crowd! And," I immediately added in a voice pitched for Connelly's ear alone, "think how *colorful* this is going to look on the newswebs." Jerry was my newest and smallest protector, a recently transplanted Virginian scarcely the size of King Kong, but he was bright enough to be a member of a certain rather exclusive club.

"Yes sir! I see your point, sir."

I was relieved to note that the reporter, set back on his feet, was merely dazed and was neither bleeding (externally) nor threatening lawsuits (immediately). I glared at my security team. You don't treat a voter like that—particularly one with a camera.

Harrowing. And inside City Hall wasn't much better. Reporters weren't the only ones with unanswerable questions.

So when I finally opened the door to my private office, my nerves were thoroughly shot and I thought, for one relatively happy second, that someone had inconsiderately parked their dog atop my desk.

Then the smell hit my nostrils.

The sheer bulk of the German-shepherd-sized beast had tricked me. I'd never seen a Majuscule in the flesh and hadn't realized, viscerally, how much bigger they were than ordinary Norway rats (and Norways can grow to nearly twenty inches long, including the scaly tail).

But no dog (I hope) had ever emitted such unfortunate odors. As I understand it, Majuscules can adjust their "command" scents to reprogram the instincts of normal rats, the Minuscules. That's how they can give their servants such specific instructions. But to me, the stench made pure ammonia smell heavenly by comparison.

No, this was no dog. No dog ever sat back on its haunches like that, lifting a hand in silent greeting, a *capable*-looking hand with a fully opposable thumb. Majuscules run on all fours, but they usually walk upright.

Horribly, the intercom was also on my desk. To use it I'd have to get within inches of the super-rodent. Avoid threatening movements, I advised myself, wondering what a Majuscule would find threatening . . .

The beast studied my timorous approach while I studied the beast. I don't know about him, but I was prepared to run like hell at any sign of trouble. Beady red eyes, reminding me of the ready lights on the cameras outside, smoldered when I finally reached the desk and pushed the button; fortunately the animal kept perfectly still.

"Dottie?" I asked my office secretary, my voice quivering like Junket in the 2010 Boston earthquake. "Can you

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please have someone bring in the Rattus translator? *Right* away?"

"Certainly, Mr. Mayor." A translator was, of course, built into the Pipette Line system; but we kept a portable one on hand in the unlikely case one of the Rat Lords suddenly dropped in.

"We'll have a translating device in just a minute," I said to my visitor, talking at half speed. This was thoroughly idiotic of me; the animal undoubtedly understood English better than most of my constituents. Not even the most radical cryptozoologist suspected the existence of master-rats until recently, but Majuscules have been studying us for a *long* time.

One of the staff technicians—I think his name was Dave, or maybe Bill—opened my door and with his back to me, tugged a wheeled cart into the room.

I'm good with names, but every one of my computer people is tall and skinny, and has long brown hair tied in a ponytail. Since he was facing the wrong way, he didn't see the Majuscule and he apparently either lacked a sense of smell, or thought he was tactfully ignoring a potent mayoral digestive problem.

I cleared my throat to warn the man something was up but technicians seem to live in a world all their own, which, at the moment, struck me as a splendid idea. Dave (or possibly Bill) glanced over his shoulder and said, "Afternoon, Mr. Mayor," and managed not to notice the visitor until he'd tugged the cart past my desk and plugged a power cable into the wall. Then nothing. No reaction whatsoever. Not even, "Gee, how'd that devil get in here?"

That would've been an excellent question. I had no idea how the devil had gotten in.

"Just press 'Enter,' sir, and you're ready to rock and roll." I watched the man stroll out the door, wondering if I could grab his ponytail and get tugged to safety.

"Testing, one, two," I said after finally locating the right key among the electronic smorgasbord on the cart. I wanted to make sure the machine hadn't been mistakenly adjusted to translate *my* voice. If this Rat Lord (or Lady) understood English, which was practically a given, a two-way translation would be sure to offend. Majuscules were known for being touchy. "Testing, three, four—"

"Wasting time, five, six, seven," came an ironically sweet, almost feminine-sounding reply, in vague counterpoint with the Majuscule's baritone squeaking.

Rattus translating machines frighten me. I don't mean there's anything alarming about the computer itself or its sampling and waveform-comparing functions. Such stuff seems like moldy old hat these days. The scary part is that the vocabulary-matching software was written by Majuscules, not humans. And the scariest part of the scary part is that while Majuscules reputedly have their own strange technology, they've apparently never built anything you or I would call a computer.

Word on the street has it that the super-rodents are very good with languages and codes. . . .

"I . . . guess it's working. Uh, welcome to my office. I'm Mayor Tully Gould, and you are?"

"Eager to reach relevance. Call me Kut, if you must apply a name. Lord Kut, since I am male and since your species cares about such trivia."

Get it together, Tully, I warned myself. The animal's skull looked no wider than a greyhound's from the front, but it stretched way back to make room for a brain as massive as Einstein's. I wondered, nervously, if sheer geometry made Majuscules particularly narrow-minded.

"I'm so glad you came by today, Lord Kut. This way we can . . . resolve our differences face to face. But it is rather unexpected. Why didn't you use the Pipette Line?" I gestured to the dedicated phone he was practically sitting on.

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"The 'Pipette Line,' as you insultingly nickname the Rattus Pipeline, depends on a human-made fiber-optic telephone cable with inadequate shielding. There is someone—or more accurately, some*thing*—that might overhear what I have to tell you this day."

"What? What?" I closed my mouth until it could stop sputtering. "I'm sorry, I haven't a clue what you're talking about. I assumed you were here about the strike? . . ."

"I am here to offer you a way to end our strike."

"Oh. Well, that's excellent! I have to admit the trash has been piling up a bit." In fact, I'd been getting complaints about the stink from as far away as Bedford. Since the Truce, rats were handling garbage in a dozen major U.S. cities, including New York, Dallas, and Seattle. Yet, inexplicably, they were only striking here. "But nobody knows why you went on strike in the first place."

"Nobody?"

"I mean none of us humans."

"*That* is why. You have an instinctual disregard for my species, for any species other than your own. We will no longer accept disregard."

"I see." I didn't see. Why were they picking on Boston specifically? Did we Beantowners have a higher level of "disregard" than folks down in the Big Apple? "I'm truly sorry and I do apologize, but what do you expect? We've only known there were intelligent rodents for—for five years now. Throughout nearly all of human history, you kept yourselves perfectly hidden. Yet we've been dealing with Minuscules for hundreds and hundreds of years, maybe thousands for all I know. Your servants have given my people *plagues,* for God's sake. If we hadn't gotten serious and started the Great Extermination in 2015, you might *never* have revealed yourselves. It's going to take time to change people's attitudes."

"Bah. And since it bears repeating, I say bah. Your prejudicial attitudes are reinforced daily. We know what is happening. Brave Majuscules watch your tedious TV and Minuscules listen on the streets and report back to us."

Surprise and fear squeezed my heart. "I thought . . . normal rats couldn't understand human languages?"

"Certainly they can't. But they can carry recording devices."

Rattus technology, according to researchers at M.I.T. after studying a few samples the Majuscules had reluctantly provided, was based entirely on tailored polymers. But what kind of polymer could record sounds? How would such recordings be played back?

Rumors of this "alien" science right here on Earth had given a lot of people, including me, a new interest in organic chemistry. I knew that the human secret of making polymers jump through hoops was in attaching useful extra molecules to the repeating strands, producing "macromolecular inclusion complexes." But only God (and the Majuscules) knew what the Rat Lords had achieved.

But I was avoiding the immediate question. "What have you heard humans saying that you take objection to?"

"Certain commonly used phrases."

"Such as?"

"'Dirty rat,' 'rat-hole,' 'rat-fink'—"

"You're kidding! Somebody living in the twenty-first century actually says 'rat-fink'?"

"The phrase appears in recent movies about past times. I wasn't finished. Other usage include 'rats' as an expletive, 'rat's ass,' 'rat—'"

"Enough! I get the point. I'll pass the word but it's going to be tricky trying to—"

"Not good enough. We require a symbolic act to prove your sincerity."

"What . . . kind of act?"

"The heroic kind."

That was a showstopper. "Heroic. Such as? And who is supposed to perform this 'heroic' act?"

"You."

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"*Me?*" I had to swallow three times to get the next words out. "Why me?" I was too busy to be heroic. Also, too small, fat, and cowardly.

"We are believers in *cities*; the concept of 'nations' means nothing to our kind. Since mayors represent cities, we require a mayor for our challenge."

"But why—"

"Since Majuscules now live exclusively on this continent, we have studied the mayors of every important American city and have concluded that only you may be proof against . . . such fearful danger. You will, however, be required to select two staunch companions."

"Now hold it right there, friend!" I wasn't keen on those words "fearful danger." "Boston still has garbage trucks, you know, and we can get them out of storage anytime we want." This was a bluff. Not only had my constituents gotten unused to the idea of a garbage-removal service run by humans, the job had garnered a powerful stigma . . .

"Anytime you want?"

I didn't let the facts stop me—you don't win elections by worrying about facts. "OK. Maybe it's taking us a while to get organized, but any day now we'll be collecting our own trash again. Remember: we don't actually *need* you. But it's such a pity. I always felt our little arrangement was superbly convenient for all parties. You should know that we're in negotiations right now with the—"

"We forbid it. Our 'little arrangement' still stands, but it is our right to strike for better working conditions. Your people have long established the precedent. And while we are striking, no human will be allowed to do our work."

Fear comes in all sizes. Suddenly I felt as if there was an icicle lodged in my throat. "How would you, uh, stop us?"

I was instantly sorry I'd asked. If Majuscules declared war, they had enough troops to guarantee catastrophe. A hostile army of intelligently guided Minuscules could . . . my imagination quailed at the thought of what they could do. We'd never had much luck at controlling the pests when they were wandering around on their own, simply trying to feed themselves.

And how many rats lived under the streets of Boston these days? Since the Truce, the population could have tripled.

My visitor's eyes seemed to glow brighter. "Perhaps we'd begin by making sure your garbage trucks lack tires. If you replaced tires with something less vulnerable, perhaps we'd consider puncturing vital fluid lines or biting through electric wires. If you managed to house all the wires and lines in—do you really wish me to continue?"

I could see it. There was simply no practical way to protect trucks or most anything else from an almost infinite army of rodents guided by Majuscules. Not unless we kept all our equipment in hermetically sealed steel vaults. And my city's aroma wasn't going to improve with its garbage trucks stored in vaults. But it wasn't damage to our *machines* I was most terrified of.

"No. Please stop." I'd already had my quota of threats for the day. "What . . . what do you want me to do?"

The idea of Tully Gould acting "heroic" was ridiculous. And while I truly love Boston, I'd put up with a whole lot more stink if the alternative was risking my supremely valuable neck. But I was horrified to realize that I *had* to go along with whatever insanity Kut had in mind. I simply couldn't take a chance that a hot war between humans and rats would erupt. Majuscules could order their subjects to attack people and all the weapons in the world couldn't protect us. . . .

"What do you want me to do?" I repeated.

Kut sat up on his haunches and stared me in the eyes. "That is the first sensible question you've asked this day and it was nearly worth hearing twice. I will tell you precisely what you are to do. I

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hope you are not a being . . . overly sensitive to fear?"

I'd had no idea I could feel this scared.

Seventy-two people were gazing at me with barely suppressed "why am I here?" expressions on their faces. The other three members of my staff were, I hoped, ignoring my words and watching my hands. I curled the ring finger of my left hand until it touched the palm, and I repeated the gesture five times while I was talking.

Even *I* wasn't listening to myself. I think I heard something about "keeping a firm resolve," and "in the face of adversity," coming out of my mouth but I've given so many speeches, I probably mumble such cliches in my sleep.

As soon as I could gracefully manage it, I dismissed everyone and was pleased to see my three co-conspirators immediately break out their sat-phones. The next half-hour I spent staring at reports without seeing them and carefully avoided going into my office.

Finally, I figured enough time had elapsed and scurried down to Meeting Room G, which is in New City Hall's lowest basement level. I grabbed a folding-chair, stared at the blank old-fashioned blackboard, and waited.

They trickled in one by one: Little Jerry Connelly; three blue-collar workers; two lawyers; a police detective; a world-famous pianist; several physicists; Lisa Stockton, my press secretary; and three college professors. When it looked like no one else was going to be able to make it, I stood up.

"I hereby declare this emergency session of the Fraternal Order Of Mu-Masons well and truly begun."

I sometimes wonder if Roland Berill and Dr. Lance Ware, who founded the high-IQ club Mensa in 1946, ever envisioned how many branches would eventually grow from Mensa's main trunk. Most offshoots were caused by internal reactions to the gradual lowering of admission requirements. Some members were serious IQ snobs and hated it when the 95th percentile riffraff were allowed to join up in 2007. Like pearls formed through irritation, *higher* IQ clubs formed within Mensa. But I founded the Mu-Masons for a different and nobler reason than mere snobbery: I wanted a kind of secret steering committee for the City of Boston, smart advisors who weren't necessarily on my payroll.

I'll admit it: I don't know what, exactly, IQ tests measure. But I'll tell you something I've noticed consistently: people who score exceptionally high on, say, the Terman Concept Mastery Test tend to be bright.

Lisa tells me I only believe in IQ tests because I score so well on them, but that's her opinion.

For a Fraternal Order, there were a lot of women in the room. "By my count," I announced, "we have sixteen Brothers here"—several lady Brothers favored me with ironic looks—"and I say this constitutes a quorum. How say you all?"

A general, slightly bored, chorus of "yeas" followed.

Our police detective spread his hands, palms upward. "What's this all about, Tully? I'm still on duty, for Christ's sake."

"Sorry, George. I need help and you are the people I can always count on. At this very moment, upstairs in my office, one of the Rat Lords is squatting on my desk." *That* news caused a stir. "He's offering a deal: I can end the garbage strike *today* . . . if I do some dangerous task for the Majuscules."

"What task?" George demanded, leaning forward aggressively in his habitual interrogation pose.

"I don't know yet. I'm supposed to choose two companions first, and then he'll tell me."

Jerry Connelly of my security staff stood up. Now *he* looked heroic with his superman build, high-school football-star face, and black, wavy hair. Connelly

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had recently moved here from Norfolk, Virginia. He hadn't been a Mu-Mason long and was meeting some of these Brothers for the first time.

"How are you supposed to choose companions, Mr. Mayor, when you don't know what you're supposed to be doin'?"

"Hell if I know. And Jerry, I'd better remind you. When Brothers are alone we use first names only."

"Sorry, Tully. I'm not in the habit."

"Here's what I was told: this job is going to take a heap of nerve and it has to be done at night. And when we find out what's what, we have to keep it secret. Any volunteers?"

Connelly stepped forward instantly. After a minute of Mu-Masons staring at each other, a tall electrician and inventor named Vince Bartolo joined him. Vince has a remarkably long pointy nose, a head that's quite flat on top, and a chin that barely shows up. He's built like a greyhound and always reminds me of Irving's Ichabod Crane.

"Little Jerry there," the new recruit said, in his throat-stuffed-with-whiskers voice, "will give you the muscle. But only I can give you the *speed*."

Connelly blinked. "That's interestin'. Are you implyin' I'm slow?"

"Compared to who, big guy?" Bartolo held out a long skinny arm. "I mean no insult. But a demonstration is in order. Try to grab my hand, Brother. Just try."

The security man hesitated, then moved like a striking snake. Instantly, Bartolo's arm became less than a blur. Connelly and I looked down; the electrician had his bony fingers wrapped around the security officer's thick wrist. From the underside.

Connelly's reaction took me by surprise. He kept staring at Bartolo's hand and grinning in sheer delight.

"Thank you, Brothers," I said. "Seems we've, uh, assembled our team. Now I'm going back upstairs to find out what the hell the team is *for*. Vince and Jerry—you might as well return to work for now, and the three of us will meet back here in, say, two hours."

Lord Kut was still on my desk and he hadn't shrunk in my absence. His contra-perfume hadn't mellowed either.

"You have chosen your companions wisely?"

"How should I know? Hard to know what makes a good accompaniment without hearing the melody first. Why couldn't you tell me what this was all about *before* I—"

"Only beings willing to face the terrible unknown can succeed in this quest."

Was he deliberately trying to scare me to death? "What quest?"

"We want you to hunt something down for us and kill it."

"*Kill?* What . . . kind of something?" I whispered.

"Deep beneath the Great Nests of Boston and New York and other cities, there are tunnels unknown to you humans. Majuscules constructed them over a century ago. Since the Truce, when we agreed that Minuscules would only enter the upper realm to remove your garbage and to feed on it, both branches of our people have largely kept to these tunnels."

"Go on."

"An ancient predator has been stalking us in our own domain, a monster beyond your imagination. This is the horror we want you to kill."

Christ! "Does this horror have a name?"

"None you would recognize, but I think I can provide one." The Majuscule bunched itself up and sprang six feet through the air to land gently on the translator-cart. "As you must know, we Lords have our own superior ways of doing things, but this device seems simple enough for any novice to manipulate."

Lord Kut fiddled with the mob of high-tech controls and uttered one of his cello-like squeaks. The translation came out, "Voracious." Then Kut did it again,

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slamming a paw down on a key in the middle of the translation.

"Vora" was the result—accent on the hard "a".

"That will do nicely," the Majuscule stated, jumping back to my desk.

"What does this . . . Vora look like?"

"You shall see for yourself—if you do not retreat screaming in abject fear."

"How big is it? At least tell me that!"

"Not so big. No more than forty or fifty human feet long."

Holy shit! "How, in God's name, am I supposed to kill something so—"

"We will provide the means. You will be using pure Majuscule technology, utterly unknown to your kind, and will be the first human in history to do so."

"I'm . . . honored." Actually, I felt more like I was fainting. "Where do we start this hunt of yours? And when?"

"Tonight. Soon. And you will begin from the basement level of this very building. Have the translator brought downstairs and I will meet you in the lowest basement corridor in three human hours. And a piece of profound advice: wear shoes with softer soles."

The Majuscule leaped to the nearest wall, stuck out a brown tongue, and touched it to a nondescript spot on the plaster. A line appeared on the wall that quickly expanded into a gap. Sections of the wall to either side suddenly curled up tighter than Florentine scrollwork and the gap became wide enough to allow the Majuscule to stride through. Kut vanished into darkness and the rolled-up faux plaster slowly curled back into place.

I leaned against my desk and waited for my hands and knees to stop shaking. Then I walked to the wall, squatted, and ran my fingers along the place where Kut had exited. It looked and felt solid, but when I tapped, the sound was unnaturally hollow.

I was impressed in a horrified kind of way. No one who hadn't been alerted would've noticed that this one rectangular area had a slightly different texture. A mere hint of a line bisected the rectangle. There were two extremely faint, slightly glossy spider-web patterns to either side of the line and each web terminated in a tiny dot near the rectangle's center. I could have touched both dots simultaneously with my thumb.

I'd heard about such doorways. Some comic referred to them recently as "rat-zippers": a kind of memory-plastic kept in one form as long as a mild electric charge was applied to the surface. As soon as the charge was interrupted, the plastic would spring into its secondary form.

My admiration was somewhat constrained because *there was a secret passageway in my personal office!*

No amount of pushing, tugging, or twisting reopened the panel and I suspected that if I hoped to open the doorway myself, I'd have to put my tongue on the dots in the center. Or perhaps that trigger spot was coded somehow only for Majuscules. It didn't matter; I wasn't up for such an experiment. The whole thing was extremely distressing. Even the thought that City Hall apparently had a subterranean egress to a giant-rat tunnel system failed to cheer me up.

I was twenty minutes late for my rendezvous with my two companions; everybody and their relatives wanted a piece of me today and I wasn't functioning with my usual suavity. By the time I returned to Meeting Room G, Little Jerry Connelly was treating Vince Bartolo like an exciting new toy.

"Watch *this*, Mr. May—I mean Tully."

"Watch what?"

"This." The security officer was casually bouncing four pieces of colored chalk of varying lengths in his right palm. Suddenly he hurled them at Bartolo. I instinctively expected sounds of impact and cries of outrage but there was nothing but an ephemeral swishing noise accompanied by a burst of soft clicks.

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The electrician had barely seemed to move; but when he opened his right hand immediately, not only was it holding the four pieces of chalk, they'd been neatly arranged in order of size.

"This gentleman here is a true freak," Connelly remarked in awe. "He's like something out of the comics!"

I shook my head in annoyance. "Brothers, I've got a slight idea of what we're up against now and I'm going to tell you all I know . . . and give you both a chance to back out. You're not going to believe this, but the Rat Lord claims that . . . "

I described the situation but, amazingly, my companions appeared more thoughtful than dismayed.

"Can we bring along our own weapons?" Connelly asked.

"Got anything likely to take out a fifty-foot long monster, Jerry?"

"Maybe."

"I sincerely hope you're kidding. We'll have to ask about weapons. So, this is it. Can anyone think of something *better* to do this evening?" I sure could.

Bartolo shrugged. "You may need me, Tully. Besides, just yesterday I was thinking that life was getting monotonous."

Connelly straightened to his full impressive height. "Looks like you got company tonight after all, sir," the security officer said firmly. "When do we leave? I should call my brother and let him know I might be a few minutes late for supper. You know what? This just might be fun."

I never claimed that a high IQ was any indicator of common sense.

When Lord Kut appeared, he wasn't alone. Four smaller Majuscules were with him and all five were walking upright. Two of Kut's entourage were supporting each end of a long, segmented pole tipped with a milky translucent globe. These bearers moved slowly, with synchronized pomp. The other unfamiliar Rat Lords were holding basket-shaped objects that glowed faintly in the dim lighting of the basement's main corridor.

The smell was astronomically powerful. I wondered if it was possible for a stink to get so strong that it would collapse into itself like a black hole.

Kut's companions deposited their burdens and departed through another secret gateway—this one at the west end of the corridor. They somehow left the "zipper" wide open. My security officer glared at the rectangular hole, shaking his head and swearing under his breath.

Bartolo was more interested in the lamps. "We humans have these modern inventions called 'flashlights,' you know," he pointed out to Lord Kut.

"Certainly. But our lamps are more reliable in the great tunnels," replied the feminine voice from the translator. "They are constructed of light-emitting plastic, far superior to the crude material you use for your TV and computer-monitor screens."

"What makes them so superior?"

"Efficiency. Once the plastic is charged, it will shine for a full day. Plus, our film transistors are completely flexible and our zinc and aluminum oxide cores are organically interwoven with shock-absorbing polymers. If you drop a human-made flashlight repeatedly, you will soon be lost in the dark."

Bartolo looked dazed, which I understood completely.

"Can we bring weapons along?" Connelly remembered to ask.

"Bring whatever you wish, but only the Staff can kill the monster." I took it that the "Staff" was the long pole on the floor.

"How does it work?" Bartolo wondered.

"If you survive, I may answer that question."

Now it was my turn. "Hold on! Why the hell do you need *us?* Why don't you use this Staff thingy yourselves? Or just send a few million rats and simply *overwhelm* the creature?"

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"We cannot. The Vora has a natural defense against us. It emits a gas no rodent can withstand; we are instantly paralyzed and the monster can dine on us at its leisure."

"Ah. You're saying the gas won't work on humans?"

"We hope not."

This wasn't what I'd call high-caliber reassurance.

Connelly burst back in. "How come humans have never seen this so-called monster of yours?"

"You never saw *us* until we willed it. You tend to be blind to anything that conducts life in the depths."

Suddenly my throat was very, very dry. What he said was true enough; the oceans, for example, were still full of mysteries. But there was another, more alarming possibility. "Is this thing . . . intelligent? Didn't you say something about it being able to tap into the Pipette—the Rattus Pipeline?"

"We believe it to be highly intelligent but its full powers remain unknown. You may soon learn more about the Vora than we ever have." The Majuscule turned to face Connelly. "Go forth and fetch whatever weaponry pleases you and I shall explain to these other two how to use the one weapon that will work. You depart in twenty-two human minutes.

"Mayor Gould alone will wield the Staff."

Twenty-two minutes took forever to pass, but that's probably because I was hanging on to each minute, clinging for dear life.

Lord Kut finished up our instructions, but didn't offer to accompany us on our mission. I was too nervous to make an exit speech, which was a first.

Bartolo and I went through the hole in the wall easily enough but for the security officer it was a squeeze. Particularly since the huge man was carrying an arsenal of grenades, pistols, extra ammunition, one of the LEP lamps, and a shotgun designed for a recently developed form of ammunition: puzzle-shot.

Connelly wanted us to "understand our resources" so he quickly described puzzle-shot. Each "screwball" was made of hundreds of small, flanged pieces. Upon firing, the weapon's rifling would get the shell spinning rapidly and centrifugal force would expand the screwball enough to keep the flanges interlocked. But when, after a hundred yards or so, the shell's spin fell below a certain RPM, it would start tumbling and would fly apart into a cloud of intricately shaped shrapnel.

The advantages over standard shells were accuracy and distance.

Connelly then offered various weapons to Bartolo and me, but since neither of us knew how to use any of them we declined.

Lamp two was in the electrician's skinny hand, and appeared brighter since it was no longer competing with the basement lights. The "Staff," which luckily telescoped down to a three-foot-long rod, was strapped across my back. It wasn't quite as heavy as it looked, but its rigidity made me feel awkward and vulnerable. It rattled a bit.

Once through the hole, we found ourselves in a narrow passageway terminating in a *very* long wet ramp. Echoes resounded disturbingly and every little noise we made seemed to swell, actually getting louder for a few seconds and never quite dying out. There was a continual but uneven low rumble, probably from traffic in the human tunnels under Boston that had been constructed in the controversial "Big Dig" due for completion in, with luck, the year 3000. We three heroes studied the route ahead and exchanged grim looks.

We three fools of disorient are . . . I'd never seen such a rampant ramp . . . fear was making my forehead sweaty and my thoughts twitchy.

In fact, the slope seemed to descend at least to the Earth's core, and it was steep enough so that we were forced to

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slither down it seated like kids on a slide. The back of my trousers was soon soggy and cold and the surface was just rough enough to be painful after a few minutes. I prayed my trousers were tougher than I was. Nobody said a word, but I was wondering how hard it was going to be to climb back *up*—assuming we ever got the chance.

The ramp ended in another narrow but level corridor, this one with a claustrophobia-inducing low ceiling. The air was warmer here but it smelled worse. An acrid, animal undertone punctuated by sharper Majuscule stenches tainted the earthy aromas of mushroom, damp stone, and mildew. Every few yards, the roof lowered until we were finally reduced to crawling. If I'd had any idea that human knees were designed to bang repeatedly into hard rock, I got reeducated.

Suddenly, the roof soared and we could walk normally. Life's simple pleasures! Then Connelly scared me half to death with a sudden grunt and the echoes made it sound as if a million pigs were attacking. "Jesus," he whispered, "I'm sorry. But get a load of this."

He squeezed to one side so we could see ahead and I almost grunted myself. We'd come to another, even more impressive ramp. This one appeared long enough to reach goddamn *Jupiter* and it was steeper than the last.

Luckily, the slope had decent traction and there was sufficient headroom so that we could stand upright and shuffle downward, our free hands braced on the ceiling. I, of course, was the only one with both hands free.

Progress was so slow and the ramp so outrageously long, I wondered if we were going to be stuck here forever. Infinity, I decided, equals eternity. My shoulders began to ache and soon felt as if they were contemplating falling off. But before I found out if such a deplorable event was physically possible, the slope began to level. Disappointingly, the ceiling was slow to take a hint and kept sinking gradually for a dozen more yards until even I couldn't stand upright.

I tried and failed to estimate how far underground we were. Then, looking around, it dawned on me that we had to be in one of the "great tunnels" Lord Kut had mentioned. This section was plenty wide but we all had to move hunched over. I thanked God that I'd inherited petite genes from my petite mother.

As we walked, small passageways began to appear randomly to either side and every time we passed one, the acrid smell grew fierce. This tunnel wasn't quite round; aside from a flat floor, it had irregular bumps and indentations marring the smoothness of the walls (or was it the ceiling?). I couldn't imagine how even a trillion rats could create such a thing or where on Earth they could have put the tailings.

But I'd recently read an article in *Scientific American* elaborating a theory that ordinary rats had, ages ago, been genetically manipulated by Majuscules to be "resource gatherers." The biologist who wrote the article suggested that there might even be specialized Minuscules we'd never seen, modified for various specific purposes. Rat miners?

By unspoken agreement we still moved single-file. Vince Bartolo led the way, his basket-lamp illuminating the path ahead. I was in the middle and Jerry Connelly guarded our backs. The electrician was swift and graceful but I was huffing and puffing in no time. I glanced down at my ample waistline in useless regret.

"Hold up," I gasped. "I need to rest for a minute."

"We might as well," Bartolo hissed. "Obstacle coming up."

Kut hadn't mentioned any obstacles. Ten yards ahead was an amber-colored, translucent, flat-bottomed disk filling the tunnel. I didn't like the look of it. We approached this object slowly and side by side.

The Vora, Kut had warned us, had a

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way of temporarily sealing off tunnel sections, but Kut had failed to reveal the lurid details. Had the *monster* put this disk in place? If so, the word "temporarily" suggested that the Vora had been right here. Recently!

Now I was panting from panic as well as exhaustion and I put a hand on the barrier mostly to keep from falling over. It was warmer than I'd expected and even felt somewhat like amber, but there weren't any prehistoric bugs inside. I pushed on it gently, then harder and harder.

"Whatever this thing is," I gasped, "it's stuck pretty damn good."

Connelly and Bartolo added their strength to mine but the result was the same.

"Stand back, Brothers," Connelly ordered before using the steel-sheathed butt of his shotgun as a battering ram. When the echoes finally died down to a steady rumble, the barrier was standing unmarred and unmoved.

"Screw this," the security man stated dispassionately. "I'll need you two to move at least twenty yards back down the tunnel."

"What are you planning on—"

"Since the tunnel curves, I can't get far enough away for the screwball shot to separate, but we'll see how well this thing handles a blast from close-range."

"All right," I said reluctantly. "But we don't know how tough the disk is, so you'd better think about possible ricochets."

Connelly chuckled. "If you weren't my boss, I might say somethin' about not teachin' Gramps to slurp soup."

As Bartolo and I backed away, I felt increasingly uneasy about the three of us being separated, even for a small distance and a short time.

"That's far enough," Connelly called after us. "When I say, 'cover your ears,' do it. I'm gonna *blow* this thing away." Sticking my head past the curve in the tunnel, I watched as he stuffed something into his ears before raising the shotgun and aiming at a careful angle. Then he yelled, "Cover 'em."

Even with my hands protecting my hearing, the explosion and its echoes sounded as if the world had come to a bad end, and I'm not talking whimper. Connelly's voice came out strangely muted when he called, "Hey, take a gander at this!"

As we ran forward, my security officer pulled out his earplugs.

The barrier was intact, but it now had one smooth hole in it that looked more like something produced by a laser than any kind of bullet.

"Interestin'. If I keep shootin', I *may* be able to make a big enough space to fit through. But we might need the ammo later on. Any ideas, Mr.—Tully?"

"I don't know. This . . . artifact feels like plastic to me, Brothers. Smooth." A feather of suspicion tickled the back of my mind. "Maybe the only thing keeping it in place is pressure. Maybe if we all shove, but on one side only? Or you might try bashing the *edge* with your rifle, Jerry, instead of the middle . . . "

Connelly turned around, half-squatted, put his back to the disk's edge, and began applying all the power of his massive legs. In this position, he took up so much of the available space that Bartolo and I could only assist by bracing his legs.

Nothing happened except the veins in the security officer's neck stood out farther and farther until he gave up, panting from exertion.

Years of experience have taught me to trust my subconscious. So when a repeating image of Connelly throwing chalk at Bartolo began to run through my mind, I assumed, unlikely as it seemed, that there was some relevance. I let my thoughts drift . . .

"I've got a nutty idea," I announced.

"My favorite kind," Bartolo stated seriously.

"I just remembered an article I once read about Thomas Edison. Maybe this

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obstacle is like Edison's chalk, or its opposite?"

"What do you mean?" Connelly asked.

"He's talking about the electromotograph," Bartolo said smugly. "Edison replaced the vibrating armature and electromagnet in a telegraph with a chemically dampened cylinder of chalk. He used an electric current to vary friction on the chalk's surface through electrochemical decomposition. All to get around a certain patent."

The security officer shrugged. "So you're thinking this thing is held in place by sheer friction? And we might be able to change that somehow with electricity? What good does *that* do us? How are we supposed to give it a charge . . . or remove one?"

"Hold the lamps closer," I commanded, sitting down and putting my face near the disk. "Oh, crap. I was right."

"About what?" Connelly wondered.

"This is like those Majuscule 'zippers.' There's some kind of circuit you can see if you get at just the right angle."

"Really? So why are you looking so sour?"

"Wait 'till you see what I have to do to activate it! Or maybe not; I'm going to try a . . . more esthetic way first."

I put a thumb in my mouth and placed it firmly against two tiny dots I'd seen near the disk's center. "Now push," I ordered.

Of course nothing happened.

I sighed. "It figures. I just knew it wasn't going to be that easy. Here's the real way to do it."

With even more distaste than I feel when someone offers me snails to eat (escargots my eye!), I placed my tongue on the dots. My mouth tingled uncomfortably and filled with a nasty metallic taste.

"Now puth," I said as clearly as I could with my tongue in the way.

I should have added "gently." With no warning, our obstacle suddenly rotated. Connelly was off-balance and he lurched involuntarily several yards down the tunnel. Meanwhile, the disk came around smartly and caught me a good one on the side of my head. Bartolo, naturally, had jumped cleanly out of the way.

"What *I'd* like to know is—" the electrician began.

"Shhh!" Connelly interrupted, holding up a cautionary hand.

We listened, but for a minute all I could hear was the "Shhh" reverberating, sounding like God was taking a shower.

Then I heard it: distant chittering, but with a power to it out of all proportion to its volume. That sound was being produced by a *lot* of small throats. I shivered in the warm tunnel.

"What were you tryin' to say?" the security man asked Bartolo quietly.

"I was just wondering where all the rats are . . . keeping themselves."

I scrutinized the floor; there wasn't so much as an old dropping. For the first time, and far too late, I began to seriously question Lord Kut's honesty. . . .

"We'd better get going," I whispered with unintentional harshness. What had we gotten ourselves into?

After fifteen minutes of overly-brisk walking, we came to a place where the tunnel divided into two and, reluctantly following instructions, we took the left branch. Less than a mile later the tunnel divided again. Kut hadn't bothered to mention a second fork.

"Left or right, Brothers?" I asked worriedly.

"Right side's bigger," Connelly pointed out. It seemed as good a criterion as any.

We hadn't gone more than a hundred yards down this new passageway when the background chittering abruptly rose to a deafening shriek. An endless stream of scrambling, leaping rodents erupted from a side-passage, swept across the tunnel practically at Bartolo's feet, and hurled itself into another side-passage across the way. The stench was strong enough to be painful and every rat was

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evidently screaming its little head off. Five minutes passed. Then ten. The three of us kept looking at each other in mounting wonder and horror.

At least twenty incredible minutes after the first one had appeared, the last animal vanished and we could continue—if we had the nerve. *Now*, there were droppings. Each of us stepped carefully over the splattered gooey area where the . . . stampede had passed.

The next barrier we came to was too wide to step over.

We'd reached a section where the ceiling had risen to a good ten feet. It was quieter here and a resonant, periodic, almost crystalline "plink," warned us there was something strange ahead.

The roof became damp, then wet; the floor developed deep craters we were forced to skirt. The air grew hot and steamy. Then, right over a large pool of water that doubtless filled the biggest crater of all, a small stalactite depended from the ceiling. One at a time, a clear drop would hang from the stalactite and fall into the pool.

But the pool was *boiling!*

"I . . . could maybe . . . throw you two across," Connelly said dubiously. The water was about ten feet wide and the floor was so slippery here that running and jumping was out of the question. Not that *I* could jump so far—not even with a tailwind. Little legs, big stomach: poor recipe for track-and-field success. But my *arms* were fairly strong . . .

"Should we just give up and go back?" the electrician wondered gloomily.

"I might know a way past this," I said slowly. "It all depends on the deepness of the pool and how sturdy this Staff is." I withdrew the weapon from its straps and pulled it out to its full nine-foot length. A twist of the final segment locked it in place. Then I placed the butt end on the floor and put more and more of my weight on the Staff until my feet were momentarily off the ground. "So far, good enough. Ever try pole-vaulting, Brothers?"

I was a bit annoyed to notice my companions gazing dubiously at my belly.

"Don't you worry about *me*," I muttered. "In fact, I'll go first."

I fed the pole into the roiling water, aiming well left of the pool's center; I didn't want to bang my head on the stalactite. I hoped the weapon would still be functional after this abuse. Luckily, the liquid wasn't as deep as it looked, only a few feet. So I clamped both hands high on the Staff, took a deep breath, took one quick step forward and jumped. At the same time, I felt a strong shove on my back. I landed on the far side of the water with several inches to spare and turned to see Bartolo grinning at me.

"Thanks for the push, Vince," I said, glowering. "But I would've made it on my own."

"Just buying flight insurance, Brother."

Connelly put his shotgun into a holster on his back and held an arm out. I swung the staff over to him and he joined me with casual ease, grasping the pole with only one hand and holding the lamp-basket with the other.

"Don't bother," Bartolo said when Connelly looked back over at him. The electrician stood at the pool's edge. He bent his knees no more than a few inches—suddenly he was standing next to me, pointing at the staff still in Connelly's grip.

The odd, milky globe at the end was now glowing a dull red. If Kut had told us the truth, we were on the right track. Or the wrong one.

I didn't dare recollapse the Staff; there was no saying when we might need it. So we had to walk much farther apart. Nevertheless, I came close to banging Bartolo with the oddly radiant tip a dozen times. The roof was lower again and I couldn't tilt the pole up very far. I wasn't sure what would happen if I actually *bit* Vince with the thing, but I didn't care to find out. This device had

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been built to slay monsters. . . .

The tunnel had gone curvy on us, twisting back and forth like a snake in agony. Half the time, I couldn't see either of my companions.

So I had no idea at first that Connelly had disappeared. But I'd gotten used to seeing a double shadow at my feet and I suddenly noticed that the shadow pointing ahead of me was missing.

"Hold up," I whispered none too quietly to Bartolo and turned around to wait for the security man.

"Jerry?" I called out softly. Nothing. "JERRY!" I shouted in abrupt uncontrollable terror. Still nothing but the echoes of my terror. I turned around.

"Dammit, Vince. Where could he have—VINCE! WHERE THE HELL ARE *YOU?*"

The electrician's lamp-basket was sitting on the floor of the tunnel, but Vince Bartolo had vanished.

I wanted out.

I was paralyzed with fear—that's a phrase I'd heard all my life, but now I knew what it meant. The Staff slowly eased to the floor from my numb hand and I couldn't move to pick it up. My body felt as if it had been stuffed with rebar and concrete.

Tiny but violent sounds I'd managed to block out until now by craftily assuming my companions were making them were suddenly as obtrusive as gunshots. Startling, hideous crunches and cracking-glass clicks randomly syncopated the uneven rumble and chittering in the air. Every new noise opened up a new chink in my mental armor allowing some new terrible thought to intrude. How many millions of tons of crushing weight were pressing down on this apparently unsupported tunnel from above?

And I was sick with worry about Vince and Jerry. Were they in agony somewhere? Had something simply . . . eaten them both? How? Jerry was strong as an ox and he'd been covered with weapons. *All* our conventional weapons, come to think of it—

And Vince? The man was so damn fast . . . how could *anything* have gotten to him without giving him a chance to at least cry a warning? My imagination had nothing but shadows to chew on and I didn't appreciate the flavor.

I don't know how long I stood there, but eventually I noticed a new sound had entered the passageway. A slithering noise, as if some vast carpet was being dragged along the ground a few feet at a time. I knew I wasn't paralyzed any more because I started shaking and my muscles felt like they were made of hot, dripping wax.

Maybe, I thought, I should just turn and run like hell.

God knows I wanted to, but I couldn't. The rumble stopped me.

Somewhere, maybe miles away or maybe close by, people were driving their cars through underground tunnels under Boston. My people. They'd put me into office twice now and I'd sworn to be responsible for their welfare. Hell, I *was* responsible! If I gave up and ran away it might trigger a ghastly interspecies war. And, far less important (but bad for my future career), the garbage would keep piling up and up. . . .

The globe on the Staff had changed from a deep, almost magenta red to orange flame. I reached inside myself for strength, found none, but picked up the weapon and Vince's abandoned basket-lamp anyway, and forced myself to walk down the tunnel to face God knows what. I didn't feel noble or self-sacrificing—just small, fat, and terrified.

From orange to yellow to green to teal, the evolving colors on the Staff's business end warned me I was getting closer to the Vora. Lucky me. I chewed my lips and somehow kept moving.

When the globe finally emitted a deep cobalt blue, hard on the eyes as a black light, I heard a tiny clunk and my basket-lamp went out. Maybe the globe *was* a

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black light by then. For the passageway suddenly glowed like a long hole punched into an endless nightmare. The walls were randomly fluorescent and fungi too flat to be seen under normal lighting displayed themselves in a thousand unearthly tints. Then I saw it.

That hideous head nearly filled the tunnel, hiding its body completely. Just as well—the head was enough. And the reek was the smell equivalent of a hurricane, too powerful to resist.

Lord Kut had claimed the monster was beyond human imagination. I don't know about that; we humans have robust imaginations. But I'll go this far: I'd never had a dream half as terrible as that face.

It was *furry*. Furry gray eyes gazed at me hungrily, a furry gray mouth opened, and a furry tongue licked furry teeth. It was pulling itself along on furry limbs more like tentacles than arms, and every time it hunched forward I felt a vibration in my feet. The Vora sniffed the air eagerly and began to speed up.

I will never, until the end of my days, know how I managed to stand my ground. When the Vora was within striking distance, its mouth opened ridiculously wide. So I shoved the staff down its throat as far as I could and waited to die.

For one eerie moment, the titanic head was illuminated from the *inside*, then everything went absolutely dark.

Sounds erupted from everywhere: thousands of squeaks that somehow combined to sound like laughter, scrabbling noises as if made by thousands of small, clawed feet, and a general rustling reminiscent of strong winds rushing through a leafy forest.

The staff fell and when it hit, I heard it shatter and heard pieces roll along the floor. One came to rest against my foot.

My basket-lamp ignited again just in time for me to catch sight of a few hundred rats dashing into various side-passages. Only one animal had stayed behind. The unmistakable figure of Lord Kut was standing in the tunnel directly in front of me. There was no sign of any monster.

I looked down at a cylindrical object touching my shoe. It was one of Duracell's latest-model lithium-ion batteries. "D" size. Another eight or nine such batteries were scattered on the floor; one was still rolling.

"What the hell!" I gasped.

To my utter amazement, the Majuscule gave me a distinctly human bow of respect. Then he turned around and waved his paw, gesturing that I should follow. I walked behind him in silence for a few minutes until I couldn't hold it in any longer.

"There isn't any *real* monster, is there? There never was! What I saw was . . . an army of Minuscules clinging to each other, *imitating* a monster. And that Staff was just a battery-powered, radio-controlled toy with some kind of color-wheel at the tip. Human technology. I'm on to you, don't think I'm not! This was all just a damn trick. Am I right?" Kut nodded but kept moving.

"What have you done with my friends?"

The Majuscule couldn't reply, of course, but he stopped and raised his hand, holding up two fingers. I groaned in frustration. "What the hell is that supposed to mean? Two of something?" He nodded again. "Two of what?"

The answer turned out to be hours. That's how long it took us to get out of the tunnels. If Kut had ever heard the phrase "as the crow flies," he hadn't taken it to heart. Instead, he led me along a route seemingly too convoluted for a mere three dimensions. After the first few minutes, I couldn't have pointed north if my life depended on it.

For some time we were alone, a little man following a giant rodent. Then during one long, straight stretch, an endless row of rats with an occasional Majuscule supervisor stood at the sides of the passageway facing inwards, standing stock-still like soldiers undergoing inspection.

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And I got glimpses of . . . things. We passed occasional openings blocked with translucent disks; some of the disks were half-open. I always peered into the vast rooms beyond and sometimes I wished I hadn't. Sure enough, Rattus technology seemed based more on strange biomechanics than mechanics.

One room had dozens of twisted trees growing under a glowing ceiling the color of my basket-lamp. Sap was dripping down the trees, collecting in buckets, and some of the sap was shining brighter than the ceiling.

Another example: imagine a large laboratory filled with inclined slabs, and lying on each slab an unholy cross between an obscenely huge rat and a tarantula. Imagine a hundred bloated abdomens exuding a thin, clear paste being woven into an assortment of shapes and textures by oversized, furry spinnerets . . .

Some rooms held even less pleasant things.

Yes, the rumors were true. Majuscules were very, very good with languages and codes—obviously including the genetic kind.

Our path led constantly upwards but so gradually it hardly felt as if we were climbing. Kut kept a steady but bearable pace and only stopped when a blank wall finally blocked our way. He used his tongue to open a "zipper."

I gladly followed him through the hole; I never wanted to see those tunnels again.

For one weird second, however, I thought we'd entered some vast rodent cathedral. Then I recognized my surroundings. We were back in Government Center, at the eastern end of City Hall's lowest level. Lisa Stockton, my press secretary and fellow Mu-Mason, was waiting for us, the faithful Rattus translator at her elbow. Her face was deathly pale but the instant she saw me, her expression lit up; her normal color returned even before she gave me a bear hug.

"Thank God! Thank God, Tully!"

"Nice to see you too, Lise. Any idea what's going on?"

"Lord Kut came to see me shortly after you left and explained what they were planning for you and why. I didn't *like* it, but—I'd better let him do the talking."

I turned to face the Majuscule. "Now. Before anything else: where are my friends?"

The super-rat gave me another deep bow. "Safe, Mr. Mayor. We have carried them to a place where they may rest comfortably and when they awaken we will lead them here."

"But what did you *do* to them?"

"Humans have taught us a million tricks." Was I crazy, or was this creature treating me with respect? "Your blowgun, for example, makes it easy to capture the fiercest animal. And our own technology supplies effective tranquilizers."

"But . . . but *why?* Why send me off to kill an imaginary monster and then ask me to bring along—"

"For trust. We had to know if you merited ours. So we did our best to build as much fear as possible in your mind and *still* you persevered."

"Once again: *why?*"

"We are an ancient race, Mr. Mayor. Consider: when mammals first walked the Earth, they looked far more like my kind than like yours. It took us eons to evolve, eons to build our civilization and learn to manipulate the world. When humans finally emerged, you were pitifully primitive and we failed to take you seriously.

"Yes, we are far older than you are; but I fear little wiser. For countless centuries we ignored humanity, allowing our servants to run amok in your cities, gathering what nourishment they could. We never once considered the consequences to you."

"Isn't this all . . . water under the bridge?"

"No. This is our deep and lasting

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shame. Then suddenly your purely mechanical technology took a biological turn we could equal but not overmatch. You began working with the stuff of life, as we have long done, twisting it to your own ends. You made a rat-specific mutagen capable of murdering *all* our servants. We were helpless—not because we lack the science to develop an antidote, but simply because there are too few Majuscules to have developed it quickly enough.

"So we revealed our existence to you and you withheld your killing hand and our Truce was formed. Majuscules had never been concerned with matters of cooperation; in our world such a thing is unnecessary. Yet when we began to take humanity seriously, we could not miss seeing the benefits of cooperation and compromise in a heterogeneous society."

Lord Kut studied my eyes, which must have been pretty wide at that point.

"If I'm hearing you right," I said carefully, "you're suggesting that humans and Majuscules might be better off working—"

"Together."

"Actually . . . that sounds like a good idea."

"Therefore we need an ombudsman. Someone humans can identify with to carry our hopes and ideas into the circles of human power and then carry human response back to us. We need a human we can *trust*."

"All right. But I think I asked you this before: why me?"

"Only the mayors represent cities and when we evaluated the mayors of the larger American cities, you were the only one who seemed intelligent and sincere enough to suffice. But we had to be sure of your mettle."

"'Mettle'!" I gave Kut my strongest scowl but there was a paradoxical feeling of pride warming my heart. "OK. I understand you now. Perhaps I will be your agent. Perhaps. And I do appreciate your confidence, but I resent like *hell* the way you've treated my companions and me. I bet this evening has taken ten years off my life. This is one Friday I'll never forget! What gave you the *right* to test me like you did?"

"Necessity . . . and something else. Just as your people set the precedent for strikes, so too you set another precedent. Those white 'mice' you experiment on in your laboratories are nothing but albino servants of ours. How many times has a rat run through a maze for *human* research?" ■

Our November issue leads off with "Club Masquerade," a new novella by Kevin J. Anderson, set earlier in the same history as "Identity Crisis," which we published last year. The course of a person's life is shaped in large measure by the events of his or her childhood—but what kind of childhood might a person have in a world where bodies and personalities are not inextricably and permanently linked?

We'll also have a memorable novelette by Shane Tourtellotte; a mixed bag of other stories by writers including Brian Plante, Rajnar Vajra, and recent Nebula-winner Mary Turzillo; and a hard-to-classify but quite clever item by another well-known Anderson, Poul.

Our science fact article, by M. Todd Washington, Ph.D., looks at a different kind of "silicon-based biology." To a seasoned science fiction reader, that term is likely to conjure up images of mobile and argumentative rocks, but Dr. Washington's topic is a bit closer to home: how can human scientists simulate in software the functions and behavior of a biological cell? That may sound simple—the cell is, after all, what we commonly think of as the most basic building block of organisms like ourselves—but it turns out to be a lot more complicated than it sounds!

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THE REFERENCE LIBRARY Tom Easton

Hammerfall, C. J. Cherryh, Eos (HarperCollins), $25, 390 pp. (ISBN: 0-06-105260-4).

Time Future, Maxine McArthur, Warner, $6.99, 447 pp. (ISBN: 0-446-60963-3).

Fool Me Twice, Matthew Hughes, Warner, $6.99, 287 pp. (ISBN: 0-446-60924-2).

Kingdoms of Light, Alan Dean Foster, Warner, $24.95, 372 pp. (ISBN: 0-446-52667-3).

Stories for an Enchanted Afternoon, Kristine Kathryn Rusch, Golden Gryphon Press (3002 Perkins Road, Urbana, IL 61802 [217] 384-4205), $24.95, 284 + xvi pp. (ISBN: 1-930846-00-92).

Flatterland: Like Flatland Only More So, Ian Stewart, Perseus, $25, 320 pp. (ISBN: 0-7382-0442-0).

The Mechanization of the Mind, Jean-Pierre Dupuy, trans. M. B. DeBevoise, Princeton University Press, $29.95, 210 + xiv pp. (ISBN: 0-691-02474-6).

NOTABLE REISSUE

Tales of the Galactic Midway, Mike Resnick, Farthest Star Science Fiction, $19.95, 556 pp. (ISBN: 1-57090-086-8).

The race against disaster is a classic science fiction theme. The disaster can be any of a great many things—alien invasion, plague, dwindling air supply, stellar explosion—you name it. The authors who have tackled them have included some of our best (as well as some of our worst), and some of the results have been memorable. Among recent examples of the type are Geoffrey Landis's *Mars Crossing* (reviewed here in January 2001) and Spider Robinson's *Callahan's Key* (November 2000).

To the list of the memorable, we must now add C. J. Cherryh's **Hammerfall**, which is not set in any of her familiar universes. This is the Commonwealth, off to one side of which lies "a small lake of G5 suns, a near circle of perfect stars all in reach of one another," rich with resources but marked by a hint of Others.

Now look at the caravan stretched out across the hot, dry Lakht. It is shepherding the mad collected across the land to the imperial city of Oburan, where the ships of the First Descended once landed and where the immortal Ila now holds sway. Among the mad is Marak Trin Tain, a general in the failed rebellion against the Ila's rule. But he is not here for his failure: when he could no longer conceal his madness, his father surrendered him to the Ila's forces and signed a peace.

The madness is a strange one of visions and voices and an insistent pull toward the East. There is no sense to it, but it is shared and common, and the Ila is collecting its victims.

Why? Marak and all the rest expect only death. Quite strangely, the Ila tells him to follow that pull to the East, learn what if anything is behind it, and report back.

So off he goes, assembling a new caravan and taking the mad with him, including two new wives, one a strong, supportive child of the desert tribes and the

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other madder than all the rest. They must cope with continued madness, lack of water, vicious sandstorms, and voracious vermin, but they make it to the edge of the Lakht and descend into an even drier basin to discover a gleaming tower, strangers, a prosperous camp of people who had once been mad, and a tale of impending catastrophe.

The Ila has enemies, the *ondat*, who long ago survived a nanotech attack by her people. Now they have found her and the people and animals she has tailored with nanotech to live in a water-poor world, and they plan to destroy her and all her works to avoid any possibility of a renewed threat. Already the asteroids and comets they have chosen to pummel the world into rubble are on their way. Already the shooting stars can be seen. Already the land shakes from the hammerblows.

But the strangers in the tower have struck a deal. If they can rescue, preserve, and rebuild, if they can use their own nanotech to overcome the Ila's, they are free to do it. The madness is their call to be rescued.

But they want more than a caravan. They want everyone. They therefore ask Marak to return to the Ila to tell her what is going on and invite her to bring all she can to the tower.

So Marak hies off again with wives and a diminished caravan while the shooting stars grow more numerous, the shaking of the land more ominous, and the madness warns him that the Big One, the Hammer that will write *finis* to all, is coming soon.

When he reaches Oburan, he finds rubble surrounded by a sea of tents. All the tribes and villages have come to the center of their universe, seeking an aid that does not exist. But wait! A new caravan can form, everyone in all the world lined up to trek across the shaking desert, racing against the Big One, slowed by the slowest among them, halted by storm, distracted by Marak's own father's assassination of his estranged wife, while the voices scream "Marak! Marak! East! East! Hurry! Faster! Now!"

Cherryh knows how to create sympathetic characters, to make you care, and that is an important part of this novel's appeal. But it is her utter command of momentum that makes this a book one cannot put down.

And in the end, only one grand question remains: What will she do for the sequel?

Maxine McArthur's **Time Future** (to be followed next year by *Time Past*) comes to us from Australia, where it won the George Turner Prize, and it is well worth the attention of anyone who loves C. J. Cherryh's work.

The setting is Jocasta, Earth's lone interstellar base. Its commander, Halley, has a challenge: Jocasta was struggling to recover from war with the alien Tor and a flood tide of refugees when the Seouras arrived, jammed all communications with the Confederacy, destroyed all ships that tried to flee, and obliged Halley to soak periodically in green slime while they try to communicate with her.

The Confederacy, by the way, is not led by humans. The alien Invidi came to Earth a century before, helped bail humans out of a number of jams, and firmly refused to share most of their technology, including their FTL drive. The Confederacy was formed soon thereafter, with the Invidi and three other species being the top-tech dominant Four, and humans and eight others being the second-tier Nine. There is, of course, resentment among the Nine and dissension among the Four.

But right now Halley has other problems. She desperately wants to call for help but can't. And here comes a battered Earth ship whose three surviving crew tell of Invidi assistance in prepping a mission to Alpha Centauri a century back. No FTL, just cryogenic suspension suitable for a fifty-year voyage.

So what are they doing here? Jocasta is a *thousand* lights from Earth! The mys-

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tery only deepens when an alien is murdered in the storage bay where some of the ancient ship's contents are stored, and it deepens further when DNA traces reveal that the killer was a Q'Chn, the warrior morph—supposedly banned at the formation of the Confederacy—of one alien species.

Poor Halley! She's exhausted, but she cannot rest. Crisis piles on crisis, and there seems no resolution in sight. But McArthur's good. Conspiracies obligingly converge, and even as Halley faces impossible choices, she draws on the history of her family—women who defied governments and gangsters to establish a small realm of freedom and autonomy on Earth—for strength. She pulls Jocasta through, and the reader feels grand relief.

McArthur is worth watching.

A game often played among fans of literature involves choosing a passage and asking the players to name its source. Shakespeare fans may want the play. Science fiction fans may ask only for the author, for the root of the game is here the distinctiveness of auctorial styles.

So let's try this one:

"Since his official investiture as the Archon's apprentice, it had become the morning habit of Filidor Vesh to take a late breakfast on the streetside balcony of a place in the Shamblings district where he was known and well treated. Fortified by slices of spiced dolcetacc and cups of steaming punge, he would linger over the pages of the *Olkney Implicator*..."

There's a good deal in even these few words—names and manneredness—to make one think of Jack Vance, but the true answer is Matthew Hughes. His new novel, **Fool Me Twice** (sequel to *Fools Errant*), offers a delightfully skewed vision of the very distant future which is much more SF than suggested by the publisher's "Fantasy" label.

Filidor Vesh is a classic ne'er-do-well, given to drunkenness, revelry, scandal, and the squandering of wealth. The Archon, Dezendah VII, is his uncle. In the earlier novel, the two saved Earth from transdimensional evil, and the Archon was sufficiently impressed by the young man's potential to make him his apprentice. But Vesh does not know how to buckle down. Within a few pages of the book's opening lines (see above), he is smitten by a lovely provincial lass who promptly steals his ID and credit card; he ignorantly grants permission for a ruinous excavation; he acquires a talking super-miniature supercomputer lodged in his head; he embarks on a ship in pursuit of lass, ID, and credit card; he is plied with strong liquor by the oily Faubon Bassariot, the palace functionary assigned to keep him out of trouble; and he is pitched overboard, only to find himself in a basket towed by a sea monster to an island prison where he will be forced to yield a bodily essence that serves the sea monsters as a powerful drug.

The kid's a screw-up. The kid's in a jam. But don't forget the voice in his head—which must, let us note, be fueled by frequent infusions of either nasty fish or cheap wine. So he has a coach. It therefore doesn't take him too long to fall in with a traveling theatrical troupe and in due time get back on the trail. Unfortunately, reports in the *Olkney Implicator* indicate that he is now a hunted fugitive, the Archon has vanished, and Faubon Bassariot has appointed himself acting Archon.

Not surprisingly, Vesh smells a plot. Fortunately, adversity is a great impetus to growing up. The lad begins to feel some sense of responsibility both to himself and to his uncle, and this time, when he finally manages to pull the chestnuts out of the fire, something sticks.

Life at last turns sweet, and the Archon smiles. So does the reader, for this Vancian adventure is a pleasure to read and Hughes is a writer to watch.

Alan Dean Foster is prolific, clever, and amusing. Very occasionally he touches on the profound, but more often he

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seems to be working too fast to be as thoughtful as profundity usually requires.

A case in point is **Kingdoms of Light** whose *raison d'être* is nothing less than running the pathetic fallacy into the ground. One commits the pathetic fallacy when one projects human feeling onto the inanimate world; authors do it when they make the clouds gather and the rain pour down for a sad or gloomy story and the Sun beam brightly for a joyous tale. Foster does it when he has the evil Totomakk Horde of the diabolical Khaxan Mundurucu invade the peaceable, idyllic kingdoms of the Gowdlands, slaughter innocents, burn, loot, rape, dine on ladyfingers that were not baked, and compose melodies on the ribs of starving children. Ooohh, they are awful!

And as if that weren't enough, they curse the Gowdlands with a hex that removes color. All is grey, and—in line with the pathetic fallacy—the surviving Gowdlanders get depressed, dispirited, and gloomy. Is there a solution? Well, the mighty wizard Susnam Evyndd fell in the final battle, but when his ashes are returned to his home, his pets—the dog Oskar, the canary Taj, the python Samm, and the cats Mamakitty, Cocoa, and Cezer—are magically gifted with human form. To them, the answer seems obvious: If color is gone, find some white light which contains all colors and bring it back.

So off they go in search of a rainbow. They find one by a waterfall and are puzzling over what to do next when evil assassins attack. They flee into the rainbow itself and find themselves in the monochromatic kingdoms of the novel's title. Since Foster is playing pathetic fallacy games, the first kingdom is the Kingdom of Red, whose residents have a bit of a temper problem. The Kingdoms of Orange, Yellow, Green, and Blue aren't much better, and when they get to the Kingdom of Purple . . .

Well, no, he doesn't take the pathetic fallacy that far. The next order of business is getting their hands on the McGuffin and fulfilling the story's mission.

As we expect from Foster, his plot moves quite briskly and the characters are likeable. But so much of the pathetic fallacy is so much too much that I am tempted to laud him for a marvelously satirical send-up. Alas, if that's what he's really up to, his publisher has let him down by presenting the novel straight.

When I reviewed Kristine Kathryn Rusch's *The Gallery of His Dreams* in May 1992, I praised her poignant novella of Mathew Brady, the Civil War photographer who saw his work as serving an anti-war purpose, only to have it bent to commercial and "art" purposes, for its point "that when we lose sight of the pain and stink and loss inherent in death, seeing instead beauty in an arrangement of corpses, we become decadent. . . . And if what we remember and lay out in galleries and celebrate is so beautiful and glorious, then perhaps it is no wonder that we keep having wars."

If you missed *Gallery* at the time, be reassured. You can find it in **Stories for an Enchanted Afternoon**, along with ten more SF tales of equal worth. As Kevin J. Anderson notes in his foreword, she is prolific, award-winning, and "a Writer with a capital W."

You won't be disappointed.

Edwin Abbott Abbott's *Flatland* was a classic in two veins, the popularization of math and early feminism. The first is obvious: Abbott imagined a world in a two-dimensional plane, whose residents, such as A. Square, had no concept of a third dimension. By introducing an alien sphere, he dramatized the idea of extra dimensions to help his readers imagine the possibility of a *fourth* dimension orthogonal to the familiar three. The feminism lay in Abbott's satiric poke at the narrow-minded Victorian society; in Flatland, males were polygons, but women were mere one-dimensional lines.

First published in 1884, the book remains in print and has spawned a num-

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ber of sequels and imitations, including Clifford Pickover's books, which also take the reader on a guided tour of mathematical wonders stretched over a rudimentary plot. Now Ian Stewart joins the parade with **Flatterland: Like Flatland Only More So**. His tale begins in Flatland itself, when Vikki Line, a very modern young lady, discovers a copy of her great-great-grandfather's *Flatland* manuscript and scans it into her computer before Papa can burn it. Promptly following the directions on how to summon a Sphere, she gets a Space-Hopper instead and is off on a tour of Planiturth's third dimension, the land of fractals, topological weirdnesses, relativity, and more, liberally sprinkled with word play and ending with an entirely fitting modernization of Abbott's antique brand of feminism.

An enjoyable excursion led by a mathematician at play.

If you are interested in the history of artificial intelligence, you will find Jean-Pierre Dupuy's **The Mechanization of the Mind** a fascinating book. Dupuy reminds us of roots most people, even in the field, have long forgotten. It was in the 1940s that a small group of mathematicians, engineers, and neurobiologists, working under the rubric of what Norbert Weiner called cybernetics, began to pursue the ideas that thinking is a form of computation and thus to be understood as an essentially mechanical or material process, and that therefore everything once taken as uniquely human or spiritual—meaning, purpose, and direction—should be accepted as a matter of physical law, and thus by no means restricted to the human. That is, it became possible to think of machines that thought. Besides artificial intelligence, the consequences include "conceptual innovations in economics, operations research, game theory, decision and rational choice theory, political science, sociology," and more.

Dupuy, a professor of social and political philosophy at the École Polytechnique in Paris, is most interested in the way the thinking of the "Cybernetics Group" led to modern cognitive science. Otherwise, he says, it was largely a dead end. It failed to grasp many of its own implications, and it ignored important insights available in the humanities and social sciences.

Perhaps a better explanation for the apparent failure of the Cybernetics Group is that it was remarkably ahead of its time. People like Weiner, Claude Shannon (who died February 24, 2001, age 84, even as I was writing this review; he suffered from Alzheimer's disease), and Warren McCulloch and Walter Pitts (who introduced the idea of neural nets) were philosophers only incidentally. They had a preliminary grasp on some very important ideas, waxed enthusiastic, and tried too hard to apply those ideas to everything within reach. It would be years before the true complexity of thinking became apparent, largely because successful attempts to mimic thinking in machines never proved able to capture more than fragments of the whole. At the same time, an enormous amount more remained to be learned about how the nervous system works (nor are we done!). In addition, the technical abilities of the time were very limited—the integrated circuit was still many years away.

Even though—or perhaps because—Dupuy is a philosopher, he is remarkably obtuse about the function of models in science. He seems to think that when a scientist abstracts a simplified model from nature, he or she inevitably confuses two senses of the term, the model as the thing to be emulated (think of role models) and the model as the emulation (think of scale models), and promptly comes to prefer the model to the reality. Yet the truth is very different: a scientific model is indeed a simplified abstraction of some aspect of reality (such as weather or thinking), but its purpose is to test human understanding of the reality; if its performance falls short of the original, that is both a sign to the scientist that

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something remains to be understood and a guide to further research. If its performance does not fall short, on the other hand, that is a sign that the scientist understands at least the crucial aspects of the reality, which is after all the goal.

As for the mechanization of the mind, we have not yet reached the state of affairs represented by that last sentence. But we're getting closer!

NOTABLE REISSUE

Almost twenty years ago, Mike Resnick published *Sideshow* (reviewed here in May 1983), a fun little novel that very quickly marked him as a very readable, pungent, and pithy writer. The narrator was the hunchbacked assistant to a venal, greedy, cold-hearted carnie owner, Thaddeus, who one day ran into a competing freak show whose freaks were actually aliens, tourists in the only disguise that could guarantee anonymity. (From their point of view, we were the freaks and they the spectators.) Before long, Thaddeus's heart softened and the carnie split. One unit stayed on Earth, a safe house for alien freaks. The other went to the stars, where it soon gave Resnick *The Three-Legged Hootch Dancer, The Wild Alien Tamer*, and *The Best Rootin' Tootin' Shootin' Gunslinger in the Whole Damned Galaxy*. The titles say it all: larger than life characters, extravagant hyperbole, and a great deal of fun of exactly the sort Resnick has made a trademark from his *Tales of the Velvet Comet* series through *Santiago* to *Lucifer Jones* and *Outpost*.

And now the whole *Sideshow* series is available in a single omnibus volume: **Tales of the Galactic Midway**. Have fun! ■

No Apparent Danger: The True Story of Volcanic Disaster at Galeras and Nevado del Ruiz

by Victoria Bruce
HarperCollins, $26.00, hardcover, 256 pages. ISBN: 0060199202

Reviewed by:
Richard A. Lovett, Ph.D.

When Victoria Bruce told me at a scientific meeting last year that she was going to Colombia to write about volcanoes, my first thoughts were typically North American: *drugs, mosquitoes, jungle, hope you come back alive*. Come back she did, and a year later handed me an advance copy of her book, *No Apparent Danger*.

It's about two eruptions linked by geography, common characters, and failures to tell people of their peril until too late. The first came in 1985, when an eruption on 17,000-foot Nevado del Ruiz melted glaciers and buried 23,000 people under mud. The second was in 1993, when scientists gathered to study another volcano, 14,000-foot Galeras. The mountain erupted when a group of researchers were in its crater, spraying them with flaming shrapnel. Amazingly, six survived, including the expedition leader, Arizona State University professor Stanley Williams, whose own book, *Surviving Galeras*, hit the bookstores only days after Bruce's.

Williams claims the disaster was one of those unavoidable tragedies that strike people bold enough to wrest knowledge from volcanic fire. Bruce charges that he failed to pass on seismological warnings the mountain was getting ready to blow, allowed his party to lollygag in the crater, and scoffed at those who carried such basic safety gear as hard hats.

Williams is a famous scientist, but Bruce has the credentials to take him on. Herself a vulcanologist, she has served stints doing science writing for NASA and the Portland *Oregonian*. More importantly, she's written an exceptional piece of investigative reporting that builds to a gripping climax. Engagingly told, sometimes lyrical, it promises to do for volcanoes what *The Perfect Storm* did for swordfishing. ■

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BRASS TACKS

Sirs,

This is obscenely ancillary. Richard Lovett's article, "The View from Space: Satellites Predict a Lot More than Weather" (February, 2001) is like a hand pointing, and I am going to comment on the finger.

He starts out talking of a government biologist using a GPS to triangulate a tortoise's position. My tax dollars go for that?!

I know that knowledge for knowledge's sake can pay some real unexpected dividends. For instance some British guy at the turn of the century studied the movement of sand. It helped the British win some battle in North Africa (Tobruk, I think). However I'd be hard pressed to think of a situation where the knowledge of tortoise migrating patterns is useful.

I paid for that?!

After the boomers I overpaid for, it probably was only a nickel, but can I have my nickel back?

William Berry

The author replies. . . .

Mr. Berry may be laboring under the impression that satellite funds are being spent for the express purpose of tracking desert tortoises. Actually, the GPS system is a military creation, and because it's already in place, there are no extra costs for its civilian use—any more than you and I alter the broadcast costs of a radio station by our decisions about whether or not to tune in. The only cost is the fairly nominal price of the GPS receiver (as little as $150). In fact, there would appear to be a cost savings to the government, because the GPS unit makes the biologist more efficient.

Alternatively, Mr. Berry may be opposed to wildlife biology in general. It's far beyond the scope of a Brass Tacks reply for me to defend the existence of an entire scientific discipline, but I can note that desert tortoise research has practical goals. Because the animals are a protected species, understanding their behavior and habitat needs is crucial to knowing what types of human development can coexist with them—valuable information whether one approves of the Endangered Species Act or not.

Richard A. Lovett, Ph.D.

Dear Mr. Schmidt,

I have been reading *Analog* for . . . well . . . a long time; I have been reading science fiction since childhood.

I generally don't read the editorials in *Analog* however, because early on I learned that there are significant philosophical differences between The Editors and myself. Since it's their magazine, and they do the heavy lifting of getting it together and publishing it, it is The Editors' privilege to use their Editorial soap box to state whatever is on their minds. I respect that. And because, on the whole, the level of writing in your magazine is very good to excellent I continue to subscribe and read the stories. I am and remain a satisfied customer (except would you guys please pick a page size and stick with it? I have about 17 years worth of back copies, and they occur in, like, 4 different page dimensions. Storing them is a mess.)

As a person of a certain theological

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bent, I found the title of your recent editorial intriguing, so I read it, being prepared at any moment to move on if I thought you were sliding into some conceptual rut. In fact, that's not what happened at all. What happened was quite different. Continuing the metaphor, you drove up to the base of a steep and difficult hill and stopped. Explicitly; you performed a good examination of a sensitive topic but stopped short of considering one last, sticky point. Tsk tsk.

In so far as you went, I agree with your editorial. Criticism of small groups of persons, individuals, or fringe behavior is not of itself an attack on the whole; regardless of whether one speaks of race, religion, species, philosophy, nationality, sexual orientation, etc. I agree that expressions of ideas that contradict the beliefs of some people/groups/religions is not an attack on them; if it were then those people/groups/religions would be guilty of attacking others when they state their beliefs.

You defend the portrayals of religious people in the pages of *Analog* (and SF as a whole) with the seemingly valid argument that bad/foolish/mean people can be found in any category of individuals; and that images of religious fringe radicalism portrayed in SF writing—specifically in *Analog* magazine—only reflects its perception in culture.

But there is something missing, which you came tantalizingly close to in your comments on Huckleberry Finn; again stopping short of. I agree that Huckleberry Finn is a wonderful and deeply anti-racist story. But it is also true that it uses racial epithets and occasionally portrays Blacks as foolish or silly; its leading character, who narrates much of the story, makes bald-faced racist comments; so how can it be anti-racist? Because it breaks the very stereotypes it employs. The occasional foolishness is only occasional; it just as often portrays Whites engaged in the same foolishness and much more often presents Blacks as being just like Whites, often better than Whites. Huckleberry Finn paints a picture of Blacks which is as sympathetic, as respectable, as heroic, and as noble as it could be to Whites.

Here is that last point you omitted. Science Fiction does not occasionally paint a bad picture of religion, science fiction only occasionally mentions religion at all, and when it does, for the most part it is an unkind portrayal. If the behavior of the religious fringe represents an exception, should not its portrayal be also the exception to the general portrayal of religion? I have been reading mainstream science fiction since I was a child; the religious character of people is rarely noted. Race, gender, physical handicaps; they all show up. Stories often make a point of saying that the protagonists and their allies are from many back grounds. But, strangely, if a religious background is discussed at all, it is usually portrayed as a character flaw. Especially if it is Christianity. Animists, Muslims, Sikhs, Buddhists, Bajorans, Klingons, Vulcans; and others; their religions usually are treated with some respect (especially if they are fictitious), but Christianity? . . . rarely. The vast majority of Americans are sincerely religious; certainly the vast majority of humanity is religious; Christians make up somewhere around 15% of the world's population; probably more. But that 15% is rarely found in SF, except when they are bad.

You write "There are, of course, a good many stories in which religion and religious people play prominent and sympathetic roles, such as Walter M. Miller's *A Canticle for Leibowitz* [1959] and Stephen L. Burns's 'Leap'. [1994?]" I will stipulate to these two though I have not read "Leap" yet and know of at least one other story to add to this short list. But are there "many" as in 'a significant fraction of the whole'? I must respectfully disagree. I have not made an exhaustive study of the subject, but I

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would wager that for any story that makes a respectful reference to Christianity there are probably ten that make disrespectful references and a hundred that omit religion entirely, no matter how completely they attempt to render their characters. You could only come up with two titles that were sympathetic to religion, one of them more than 40 years old. The one I am thinking of is on the same order of age (by Blish? Can't recall at this moment; a missionary on a planet populated by intelligent dinosaurids.)

Consider your reference to Hitler. Suppose someone accused SF of being generally sympathetic to Hitler's ideas. Your best defense would be to point out that sympathetic portrayals are rare and that the vast remainder either ignores Hitler's ideas or plainly condemns them. This, you could justly say, proves that SF as a genre rejects and/or condemns Hitler's ideas. In fact, you came close to making this argument as part of your case. Fair enough.

Now change the topic to religion, especially Christianity. One can fairly say sympathetic portrayals are rare and that the vast remainder either ignores religion, especially Christianity, or plainly condemns it. This, one could justly say, proves that SF as a genre rejects and/or condemns religion; especially Christianity.

If the references to religion which people complain about, the ones you talked about, were the exceptions, then you would have a strong case. But they are not, these objectionable references form the bulk of all references to religion. It is the religion-as-a-neutral-trait references which are rare; the character who sits competently as watch officer, reading his Bible as the rest of the crew slumbers.

I can offer one bit of consolation, SF is no worse at this than current literature is in general; but that is faint praise indeed.

Sean M. Samis

For the most part you've written a thoughtful letter and made some points that writers might do well to consider. However, I fear you've also made some subtle errors of your own.

It's not true that I "could only come up with two titles . . .";I only mentioned *two, but I said quite clearly that they were* examples, *not an exhaustive list. On the other hand, I seriously doubt that you can come up with many examples of stories that insult Christianity, though you may well find many that critically portray individual Christians or groups—which, as I said in the editorial, is not at all the same thing. Failure to make that distinction is, in fact, one of the "three commonest errors" that I mention.) I can agree that many stories simply don't mention religion (or the lack of it), but that's irrelevant to this argument. No characterization, especially in short fiction, tells* everything *about a character, and a person's religion often simply isn't important to what's happening, at least to anyone except that person. (That's true in real life, too; I don't know the religious affiliation, if any, of many of the people I associate with, including some whom I otherwise know quite well.) Since so many interfaith hostilities unfortunately exist, a writer may be well advised simply not to bring a character's religion up unless it has some bearing on the story. Race, gender, and physical handicaps are usually so obvious they* have *to be mentioned; religious affiliations, or lack of them, often aren't.*

Your Hitler example is not a valid analogy. There you're talking about different writers' portrayals of a single historical character, or small group of them, which is not at all the same thing as independent portrayals of a lot of different characters who share a single religion. (Or perhaps I should say family of religions, since members of different Christian denominations, for example, often make sharp distinc-

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tions among those denominations and don't consider their beliefs at all equivalent).

Oh, by the way . . . I believe the James Blish story you're thinking of is A Case of Conscience.

Dear Mr. Schmidt,

Analog magazine came today. I read your editorial and liked it. But I'm a cursed quibbler. You said that you didn't think the magazine should publish stories that depict Hitler's ideas as good and should be acted upon. I beg to cavil.

First, I think Fascism was/is an evil that the world is well rid of. I think I should do everything that I can to make sure that Hitler's ideas are consigned to the ash-heap of history. My quibble is how to do that.

I think that the Nazi should be allowed his say with complete openness. Alongside the Nazi tract, we ought to publish a rebuttal. The rebuttal should go through the vile matter and debunk its falsehoods point by point. The errors of the past ought not be censored, but shown in all their infamy. I guess I'm advocating a metaphorical Holocaust Museum around every pro-Hitler publication.

I believe we're very close to agreement and I hope you weren't annoyed at my quibbling.

Steve D. Poling

Annoyed? Not at all! But I do think there's a subtle but important distinction you're not making. I agree that people should be free to propound any idea they want—at their own expense—and that others should be not only free, but encouraged, to point out any fallacies they think they see. But there's a big difference between that and saying that our magazine should publish stories advocating Hitlerian ideas. Our function is not to provide an open forum for everything that anybody wants to say; that would be impossible anyway, with our limited page space. Our job is to present a selection of that science fiction that we think our readers will most enjoy reading. We only have room for about 1% of what we're offered; the reason we're not likely to publish any pro-Hitler stories is that we're unlikely to like such stories enough to think they belong in that 1%.

Nor would I want to start a practice of publishing an editorial critique alongside every story, which could quickly become quite loathsome; and it would be very difficult to do that for some stories but not all. Our general policy is not to editorialize on any story, but to let the writer say what he or she wants to without much comment from us—but then to let the readers tear into it with any comments it might inspire from them. Space for that is very limited, too, in the magazine itself—but the "Forum" section of our website (www.analogsf.com) is wide open and some very lively discussions take place there. (There were, in fact, some comments on this very subject that I'd like to include here, but Forum discussions tend to be scattered through exchanges of notes so conversational in tone that they don't lend themselves to printing as self-contained letters.)

Dear Dr. Schmidt,

Your editorial "Beliefs and Believers" in the April, 2001 issue was right on the money! It makes me proud to be a 15 year subscriber!

The alarming trend of religious fanatics today to try and suppress discussion of any of the "Big Questions" that don't agree with their limited, biased viewpoints is downright scary.

Whether or not it has an impact on the science fiction world I think will depend a lot on readers who continue to demand intelligent, erudite stories that aren't afraid of addressing the Big Questions—instead of the derivative, escapist "sci-fi" trash found in most bookstores

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these days. And, as usual, *Analog* is right on the front lines in the controversy.

Tackling the Big Questions is nothing new for science fiction. For example, consider the 1967 Nebula Award winning novella *Behold the Man* by Michael Moorcock. Now pretend that it was written today and visualize just how the religious fanatics would react to both it and the award it received!

I think that Jack Vance best summed up the mentality of the religious fanatic back in 1969 in his novel, *Servants of the Wankh*:

"It occurs to me that the man and his religion are one and the same thing. The unknown exists. Each man projects on the blankness the shape of his own particular world-view. He endows his creation with his personal volitions and attitudes. The religious man stating his case is in essence explaining himself. When a fanatic is contradicted he feels a threat to his own existence; he reacts violently."

Greg Walz
Pittsburgh, PA

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Webs of Wonder **September 11 @ 9:00 p.m. EST**
David Brin, Julie E. Czerneda, and James Van Pelt talk about SF in the classroom.

Go to **www.scifi.com/chat** or link to the chats via our home page (**www.analogsf.com**). Chats are held in conjunction with *Asimov's* and the Sci-fi Channel and are moderated by *Asimov's* editor, Gardner Dozois.

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UPCOMING EVENTS Anthony Lewis

5–7 October 2001
ALBACON 2001 (Capital area SF conference) at Ramada Inn & Convention Center, Schenectady NY. Guest of Honor—Larry Niven; Artist Guests of Honor—Bob Eggleton & Marianne Plumridge; Fan Guests of Honor—Bonnie & Ted Atwood. Registration—$33 until 10 September 2001, $45 at door (checks to LASTSFA). Info—Albacon 2001, Box 2085, Albany NY 12220-0085; URL—www.albacon.org

5–7 October 2001
ARCHON 25 (St. Louis area SF conference) at Gateway Center & Holiday Inn, Collinsville IL. Guest of Honor—Robert Jordan; Artist Guest of Honor—David A. Cherry; TM—George R.R. Martin; Games Guest of Honor—Steve Jackson; MC—Vic Milán. Registration—$35 until 31 August 2001, then $40. Info—Archon 25, Box 8387, St. Louis MO 63132-8387; (636)326-3026; e-mail—archon_hotline@zellich.net; URL—www.stlf.org/archon/25/index.html

5–7 October 2001
TRINOC*CON 2001 (North Carolina SF conference) at Durham Marriott, Durham NC. Guest of Honor—Vernor Vinge; Artist Guest of Honor—Dru Blair. Registration—$30 in advance, $35 at door. Info—Trinoc*con Corporation, Box 10633, Raleigh NC 27605-0633; e-mail—info@trinoc-con.org; URL—www.trinoc-con.org

12–14 October 2001
ICON 26 (Iowa SF conference) at Ramada Westfield Hotel, Coralville IA. Guest of Honor—L.E. Modesitt; Fan Guest of Honor—Dennis Lynch; TM—Rusty Hevelin. Registration—$35 until 3 September 2001. Info—Icon 26, Box 525, Iowa City IA 52244-0525; (319)626 2099; e-mail—icon@mindbridge.org; URL—www.mindbridge.org/icon

19–21 October 2001
INCON 2001 (Spokane area SF conference) at Spokane Shilo Hotel, Spokane WA. Guest of Honor—Jane Fancher; Artist Guest—Mark Ferrari. Registration—$20 to until 1 October 2001, $25 thereafter and at the door. Info—InCon 2001, Box 9112, Spokane WA 99209-9112; e-mail—incon2000@hotmail.com; URL—incon.skywalk.com

1–4 November 2001
WORLD FANTASY CONVENTION 28 at Hotel Delta Centre-Ville, Montreal, Quebec. Guests of Honor—Fred Saberhagen, Joel Champetier, TM—Charles de Lint. Registration—Attending: $125/C$175 until 30 June 2001, Supporting: $30/C$45 until 15 October 2001 (latest information at press time). Info—2001 WFC, c/o Bruce Farr, Box 7191, Chandler, AZ 85246-7191, (602)395-1945; email—brucex.farr@intel.com; URL—www.worldfantasy.org /wfc01.html

Convention runners: If your convention has a telephone, FAX, email, or Web page URL, please let us know so that we can publish this information.

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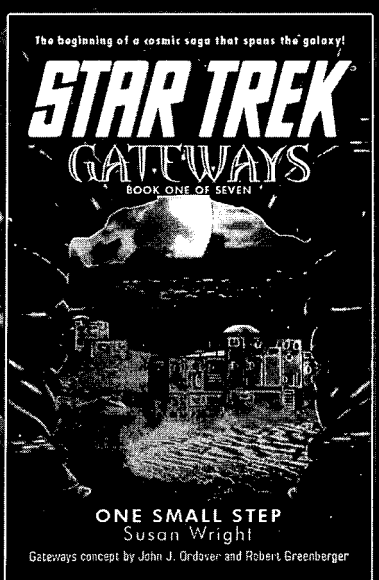
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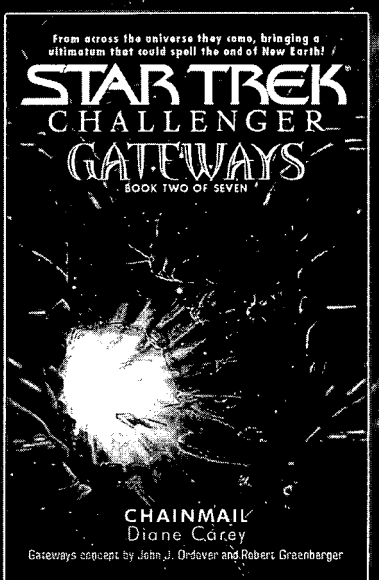
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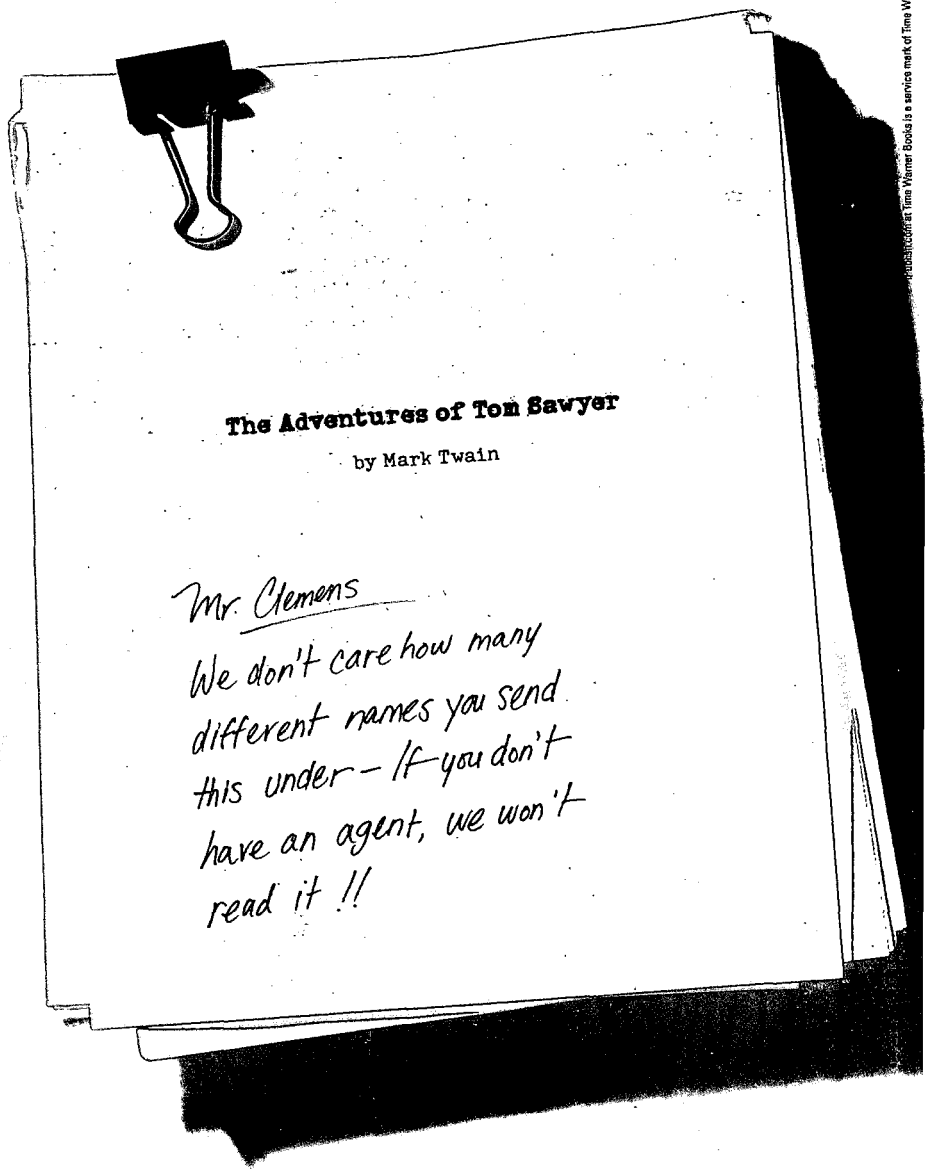
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